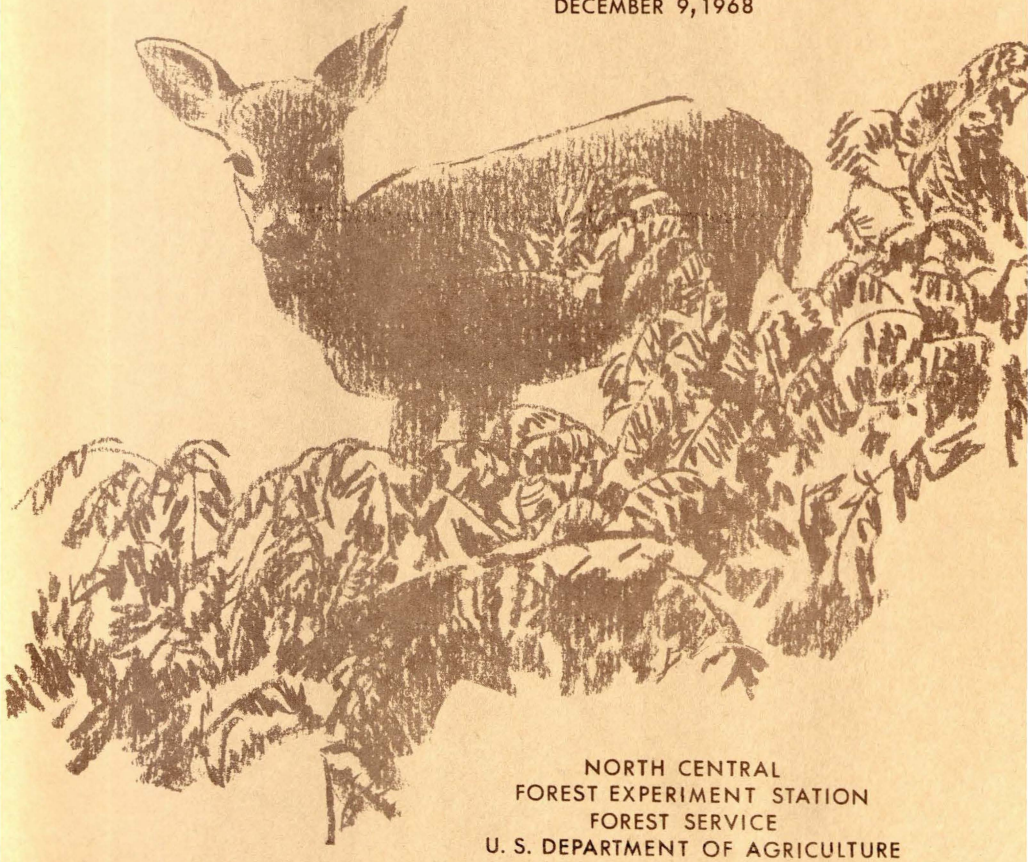
U.S.D.A. FOREST SERVICE
RESEARCH PAPER NC-39
1970

White-tailed Deer in the Midwest

A SYMPOSIUM, presented at the 30th Midwest Fish and Wildlife Conference, Columbus, Ohio
DECEMBER 9, 1968



NORTH CENTRAL
FOREST EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

CONTENTS

Introduction 1
Louis J. Verme

Deer Range Appraisal in the Midwest 2
Dean A. Murphy

Deer Populations in the Midwest 11
Charles M. Nixon

Midwestern Deer Habitat 19
Hewlette S. Crawford

Harvest Regulations and Population Control for Midwestern Deer... 23
David H. Jenkins

Some Remarks on Yarding Deer 28
Louis J. Verme

Discussion 29

Summary 34
Louis J. Verme

North Central Forest Experiment Station
D. B. King, Director
Forest Service - U.S. Department of Agriculture
Folwell Avenue
St. Paul, Minnesota 55101

FOREWORD

Research at the North Central Forest Experiment Station is concerned with developing forest management systems to favor all kinds of forest resources, including wildlife, so we welcomed the papers of the deer symposium reported here. The fact that the participating researchers added their personal opinions to the factual data presented adds value for research planning.

We are happy to publish this timely contribution to the understanding of deer management problems in the Midwest.

D. B. KING
Director

PREFACE

When I accepted the assignment as Technical Game Session Cochairman of the 30th Midwest Wildlife Conference, I did so with the thought that here was an opportunity to consider and discuss an important, and largely neglected, aspect of wildlife management — the nonyarding white-tailed deer population of the Midwestern United States. Deer in the agricultural-hardwoods belt of the Midwest have not received the attention given their yarding cousins to the north. This is not difficult to understand. To a great extent, we have permitted deer populations of the midwestern farm belt to grow "like Topsy," since they have not yet been nearly the management problem that our yarding deer have been.

Others agreed with the importance of this topic, and the biologists I contacted were willing to participate in the symposium. Mr. Dean A. Murphy, Deer Research Biologist, Missouri Department of Conservation, was asked to report on deer range appraisal. Mr. Charles M. Nixon, Forest Game Research Biologist, Ohio Division of Wildlife, was selected to discuss deer populations. Dr. Hewlette S. Crawford, formerly Wildlife Ecologist, North Central Forest Experiment Station, now with the Southeastern Forest Experiment Station, Blacksburg, Virginia, agreed to report on deer habitat. And Dr. David H. Jenkins, Chief of Research and Development Division, Michigan Department of Natural Resources, was selected to discuss harvest regulations and population control. Mr. Louis J. Verme, Game Research Biologist, Michigan Department of Natural Resources, agreed to be the panel moderator.

Perhaps the most significant contribution of this symposium is that for the first time we have looked upon the deer of this vast area as a more or less discrete population. We know a great deal about our farm belt deer; much remains to be learned, however. Hopefully, this symposium will be a first step in arriving at management programs to meet the challenges of the next few decades.

THEODORE A. BOOKHOUT
Unit Leader
Ohio Cooperative Wildlife Research Unit
Ohio State University

WHITE-TAILED DEER IN THE MIDWEST

A Symposium

Presented at the 30th Midwest Fish and Wildlife Conference

Columbus, Ohio

December 9, 1968

INTRODUCTION

LOUIS J. VERME
Michigan Department of Natural Resources
Shingleton, Michigan

This symposium deals with the present status and future prospects of the white-tailed deer *(Odocoileus virginianus)* in the Midwestern United States. This region encompasses the southern portions of Michigan, Wisconsin, and Minnesota, plus all of Ohio, Indiana, Illinois, Iowa, and Missouri. However, it is also appropriate to include the Dakotas, Nebraska, Kansas, and those provinces of Canada having sizable herds of white-tails on primarily agricultural range.

I emphasize at the outset that this symposium deals only with nonyarding deer; that is, animals which, because of favorable habitat conditions and relatively mild weather, usually are not confined in sites of heavy cover for any extended winter period. They may, of course, temporarily band together for safety, or for other reasons still poorly understood. Nevertheless, this is in sharp contrast to the distinct yarding behavior of deer in the northern Lake States region. Because most of my experience has been with yarding deer in the cedar swamps of Michigan's Upper Peninsula, I accepted the task of panel moderator with some trepidation. Fortunately, the panelists have prepared excellent reports on the subject of nonyarding deer.

Perhaps prior to this decade, an "in-depth" discussion of midwestern deer would have seemed premature and largely superfluous. Obviously, most of our attention was, and to some extent still is, directed toward managing the vast herds on the northern ranges. Presently, however, considerable research effort is shifting southward, as it should.

The increase of white-tails in the midwestern farm belt occurred rather surreptitiously, and almost unnoticed except by a few biologists. The great reproductive capacity of corn-fed deer, together with favorable land-use practices, changed the picture dramatically. Generally, the small, scattered herds grew rapidly to surprisingly high levels over much of the region. This is fortunate, as herds in the northern Lake States are experiencing a serious population decline. Possibly within several years, for example, the kill of adult bucks in southern Michigan may equal or exceed the number taken above the Straits of Mackinac. And only shotguns are legal arms in the populous lower third of that State.

Today the panelists will endeavor to analyze and summarize virtually everything that is known about midwestern deer. This is quite an accomplishment. Beyond reviewing the literature, they sent questionnaires to various State agencies requesting unpublished, up-to-date reports on specific points of the overall situation. Because the environment and amount of research that has been conducted varies throughout the region, the job of assessing the data received undoubtedly was difficult. Some overlap in material or occasional contradictions are to be expected. The findings to be presented surely will pose more questions than are answered. Yet, the real objective of this symposium is to invite searching criticism and reappraisal of our progress in managing midwestern deer properly.

DEER RANGE APPRAISAL IN THE MIDWEST

DEAN A. MURPHY
Missouri Department of Conservation
Jefferson City, Missouri

ABSTRACT

That portion of the North-Central United States in which white-tailed deer (*Odocoileus virginianus*) do not concentrate in yards during winter was divided into three broad range classes — Northern Transitional, Agricultral, and Central Hardwoods. The classes were based on differences in land use, forest types, and amount of woody cover. Woody cover was judged to be adequate except in the Agricultural Range Class, where it is being rapidly diminished by competing land use. It was recommended that efforts be directed toward inventorying woody cover, and determining rate of loss and possible methods for preserving existing cover. A review of published data and a questionnaire survey of the States in the region indicated a need for additional information on the basic components of range appraisal. The greatest amount of information was available on food habits of deer. Data were generally inadequate on quantity of forage available, quality of forage, nutritional requirements of deer, forage inventory methods, effects of utilization on forage plants, trends of range condition, and carrying capacity. Additional research was recommended on the effects of even-aged management in oak-hickory forests and on the factors influencing production of acorns and wild fruits.

The biological goal of white-tailed deer management is balancing deer population levels with carrying capacity of the range. The goals of deer range appraisal are: delineating habitat types, determining carrying capacity of the various habitat types, and determining factors influencing carrying capacity. Information needed to achieve these goals includes: (1) distribution and adequacy of woody cover, (2) food habits of deer, (3) quantity of forage available, (4) quality of forage available, (5) nutritional requirements of deer, (6) trends in forage production, and (7) factors influencing forage production. This paper will summarize our present knowledge of the above factors and describe needs for additional knowledge of the habitat of nonyarding deer in the Midwestern United States.

The help of many people was necessary in this attempt to summarize deer range appraisal in the North-Central United States. The following persons responded to my questionnaire and generously furnished publications that I might have otherwise overlooked: Paul D. Kline, George F. Hartman, David H. Jenkins, John M. Idstrom, Richard M. Bartholomew, John C. Calhoun, and Charles M. Nixon.

RANGE CLASSES

The range of nonyarding deer in the North-Central United States occupies approximately the southern four-fifths of the region (fig. 1). Range types within the nonyarding area can be separated into three broad classes according to forest types and amounts of forest area (fig. 1). For purposes of discussion, I have named these range classes (1) Northern Transitional, (2) Agricultural, and (3) Central Hardwood.

The Northern Transitional Range Class occupies the northern edge of the nonyarding area and is a gently rolling to hilly transition zone between the boreal forest types (spruce-fir, aspen-birch, and northern hardwood) and the Agricultural Range Class. About 40 percent of the area is wooded.

The Agricultural Range Class occupies the central part of the nonyarding area. It is characterized by a limited amount of forest cover (less than 20 percent) and level to gently undulating topography. Woodlands generally are present as scattered woodlots of oak-hickory or as bottomland hardwoods (elm-ash-cottonwood-sycamore) along streams.

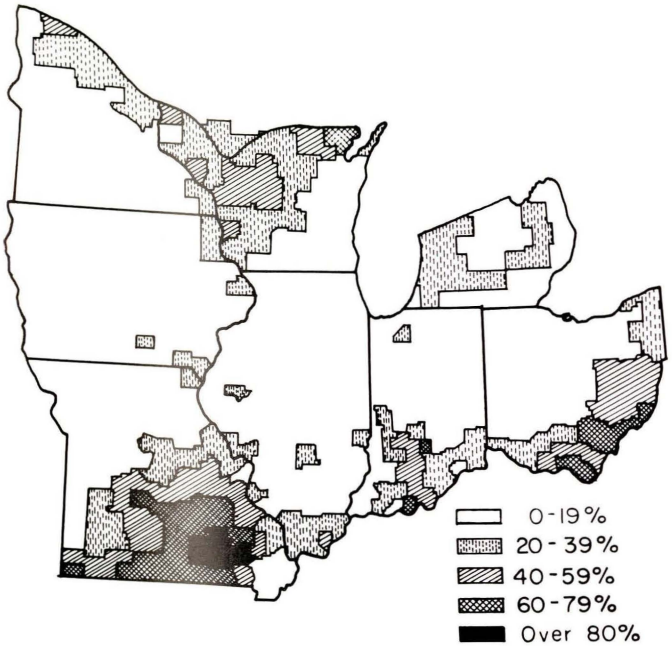


Figure 1. — Forest cover in the Midwest.

The Central Hardwood Range Class occupies the generally hilly southern portion of the nonyarding area. Oak-hickory forests are predominant and generally occupy more than 50 percent of the land area. Some beech-maple forests occur in the eastern part of this range class, and oak-pine stands are found in the southern portion.

Climate is variable over the region. Temperature extremes range from —30° F. to +105° F. but are of short duration. Frost-free seasons vary from 160 to 210 days. Precipitation ranges from 25 to 60 inches, with annual short droughts common in the south. Annual snowfall ranges from 10 to 15 inches in the south to over 50 inches in the north (DenUyl 1962, p. 144).

DISTRIBUTION AND ADEQUACY OF COVER

Woody cover is probably adequate in the Northern Transitional and Central Hardwood Range Classes. In some areas, such as the eastern Ozarks of Missouri where forests occupy over 80 percent of the land, cover may be more than adequate because large solid blocks of timber are not optimum deer range.

Deer and forests have always been related in the minds of men. However, the rapid increase of deer in the Agricultural Range Class has demonstrated that deer can adapt to astonishingly small amounts of woody cover. A prime example is in Iowa, where deer have increased in numbers and distribution (Kline 1965) even though the average county in Iowa is only about 8 percent forested. However, the acreage of woody cover cannot be considered adequate throughout the Agricultural Range Class. More of the total land area could be occupied by deer if additional woody cover were available.

The distribution of woody cover as shown by aerial photos was one criterion used by the Wisconsin Department of Natural Resources in determining the number of square miles of deer range in each deer management unit.[1]

FOOD HABITS

Some of the earliest food-habit studies consisted of compiling lists of foods eaten by deer. These lists

[1] *Personal correspondence with A. D. Doll, Wis. Dep. Natur. Resources.*

showed that deer eat a great variety of foods. Atwood (1941) listed 614 plants eaten by white-tailed deer. His references from the midwestern region showed 204 plants taken by deer. More detailed studies of forage utilization and analyses of deer rumens showed that, although deer sampled many foods, a few items generally constituted the major portion of the diet. A major consideration in any food-habit study is, "Do the findings represent preference (palatability) or availability of food items?" I believe that "habit" or "custom" may influence deer utilization of different plants in different areas.

Northern Transitional Range Class

Food-habit studies are relatively limited, but the available information indicates that deer eat mainly native forage and take agricultural crops when available.

Dahlberg and Guettinger (1956, p. 254-255) presented a checklist of 110 trees and shrubs browsed by deer in Wisconsin. Plants were rated as first, second, third, or fourth choice. The first choice plants in southern and central Wisconsin were red maple (*Acer rubrum*), staghorn sumac (*Rhus typhina*), alternate-leaved dogwood (*Cornus alternifolia*), wintergreen (*Gaultheria procumbens*), and wild cranberry (*Vaccinium oxycoccos*).

Erickson *et al.* (1961) reported on the contents of nine rumens from deer in west-central Minnesota. Corn (*Zea mays*), rose (*Rubus* sp.), smooth sumac (*Rhus glabra*), wolfberry (*Symphoricarpos* sp.), green plant parts, and gooseberry (*Ribes* sp.) were the most important items by volume.

Agricultural Range Class

Food-habit studies based on rumen analyses indicate that agricultural crops, especially corn and soybeans (*Glycine max*), form a major portion of deer diets in this range class.

Mustard and Wright[2] found that cultivated crops made up 56 percent of the diet, by volume, in Iowa. Corn accounted for 40 percent and soybeans 13 percent. Buckbrush (*Symphoricarpos* sp.), oak, and apple (*Pyrus malus*) were the major browse items.

Cultivated crops made up 48 percent of the food volume of deer rumens from western Ohio (Nixon and McClain 1968). Corn composed 34 percent, acorns 14 percent, wild crab (*Pyrus coronaria*) fruits 14 percent, and soybeans 12 percent by volume of 168 deer rumens. Wild fruits and seeds also were major food items.

Rumen analyses of 138 deer from northern Missouri (Korschgen 1962) showed that although 41 percent of the total volume was agricultural crops, oak leaves and acorns (25 percent) were as important as corn (21 percent). Forbs (14 percent) and browse and wild fruits (12 percent) were also important.

Although food-habit studies are not available, crop damage complaints furnish an index to deer use of agricultural crops in southern Minnesota and Wisconsin. Corn (50 percent of claims), truck crops (20 percent,) hay (9 percent), and oats (*Avena sativa*) (9 percent) were the crops damaged most frequently in Minnesota (Erickson *et al.* 1961).

Wisconsin pays indemnity for damage by deer. From 1931 through fiscal year 1966-67, the Wisconsin Department paid $778,129 for deer damage. Claims annually exceeded the funds appropriated for damage payments. The largest percentage of claims involved small grains and truck gardens (20 percent each). Soybeans and hay (19 percent each) were the other major crops damaged. Corn constituted only 9 percent of the claims.

Central Hardwoods Range Class

Food-habit studies indicate that deer in this range class utilize native forage (acorns, wild fruits, forbs, and woody browse) more than cultivated crops.

Fruits and seeds constituted 61 percent of the volume of deer rumens from northeastern Ohio (Nixon and McClain 1968). Farm crops constituted only 18 percent of the diet. The most important items were wild crab, acorns, and corn.[3] Dexter *et al.* (1952) found apples, soybeans, and corn to be important food items in 90 deer rumens from northeastern Ohio.

In the hill counties of southeastern Ohio, woody vines, especially Japanese honeysuckle (*Lonicera japonica*), are important deer foods (Nixon and McClain 1968). Rumen analyses showed that woody vines (16 percent by volume), forbs (17 percent), and fruits and seeds (40 percent) were much more important than cultivated crops (9 percent). Wild crab, honeysuckle, corn, greenbrier (*Smilax rotundifolia, S. hispida, S. glanca*), and sumac (*Rhus copallina, R. glabra*) were the most important items.

Preferred deer foods in Indiana were listed by Allen (1955) as poison ivy (*Rhus radicans*), sassafras (*Sassafras* sp.), mints (*Labiatae*), plantain (*Plantago* sp.), honeysuckle, greenbrief, sumac, and wild grape (*Vitis* sp.).

Rumen analyses of deer from the Missouri Ozarks also illustrated the dependence of deer on native forage (Korschgen 1962). Acorns were the most important single item. They comprised 53 percent and

[2] *Mustard, E. W., and Wright, V. Food habits of Iowa deer. 1964. (Unpublished report by Iowa Conserv. Comm., Pittman-Robertson Proj. W-99-R-3.)*

[3] *Personal correspondence with C. M. Nixon, Ohio Div. of Wildlife.*

54 percent, respectively, of the volume of deer rumens in the eastern and western Ozarks. Farm crops made up only 5 percent of the volume in the eastern Ozarks and 3 percent in the western Ozarks. Corn was not identified in any of the 80 rumens from the western Ozarks. Other important foods were forbs (including grass and sedge), browse, and wild fruits.

A different approach to deer food-habit studies in the Missouri Ozarks was taken by Dunkeson (1955). He followed semitame deer in an enclosure and recorded the plants they ate. His study indicated that forbs constituted the largest single class of deer food on an annual basis. Browsing on woody shrubs also extended over a long period of time, but much of the browsing in winter was incidental to consumption of fruits or seeds. Acorns were important when available, and seasonal use was made of ferns, grasses, and mushrooms. Basal rosettes of aster (*Aster* sp.) and goldenrod (*Solidago* sp.), along with pussy-toes (*Antennaria plantaginifolia*), provided green food throughout the winter.

QUANTITY OF FOODS

There is little information available on production of deer food on the various deer ranges under consideration. Food-habit studies indicated that agricultural crops form a major portion of the diet in the Agricultural Range Class. Therefore, a knowledge of the quantities of native foods available probably is not important in that range class.

Deer rely more heavily on native forage in the other two range classes, and a knowledge of quantities available is basic to appraisal of those ranges.

Gysel and Stearns (1968) reported on deer food production under oak stands in central Lower Michigan. Undisturbed 55- to 80-year-old stands produced 200 to 500 pounds (green weight) per acre of browse. Clearcutting of the overstory trees produced yields of 500 to 1,000 pounds per acre. However, a major portion of the increase was oaks and other species listed as third-choice foods by Dahlberg and Guettinger (1956, p. 254-255).

Dalke (1941) reported green weights of deer browse from three cover types in the Missouri Ozarks. Average production was 140 pounds per acre in the post-oak (*Quercus stellata*)-blackjack oak (*Q. marilandica*) type, 111 pounds in the black oak (*Q. velutina*)-hickory type, and 61 pounds in the ravine type.

An extensive survey of deer forage on National Forest lands in the Missouri Ozarks[4] gave estimates of deer food production by forest types, stand-size stocking classes, and various other factors. The quantity of deer food available was quite low in most forest types. The study was made before even-aged management was adapted for hardwood stands and applies only to those stands that have not been cut as prescribed by the even-aged management guide (USDA Forest Service 1962).

Basic to any analysis of the quantity of food available is an understanding of the daily requirements of deer. Although no studies have been conducted within the boundaries of the region under discussion, the findings of several studies are pertinent. Jenkins and Bartlett (1959) stated that Michigan deer in winter required 4 to 7 pounds of food daily per hundred pounds of body weight. Dahlberg and Guettinger (1956, p. 76) concluded from pen studies that Wisconsin deer required 3.5 to 5.5 pounds of browse per hundred pounds of body weight. Duvendeck (1962) found that penned deer in northern Michigan ate 4 pounds of good browse per hundred pounds of body weight and would consume 1.5 pounds of acorns per hundred pounds of body weight per day when acorns were available.

The importance of acorns, fruits, and seeds to deer in the Midwest was evident in our discussion of food habits. Additional information is also needed on yields of these important food items. Christisen and Korschgen (1955) reported a potential average yield of 20 pounds per acre of mature, insect-free acorns from an ordinary stand of oaks in the Missouri Ozarks.

QUALITY OF FOODS

Data are also limited on quality of deer foods available in our area of discussion. There can be little argument that corn and soybeans are high-quality foods; therefore, such studies for the Agricultural Range Class are unnecessary.

However, in the areas where deer are more dependent on native foods, quality of forage may be important. As Dahlberg and Guettinger (1956, p. 76) stated, "Browse plants of high palatability do not necessarily have a high nutritional value." Chemical analyses of preferred winter deer browse plants from the Missouri Ozarks are a good example (table 1). Woody browse in winter probably should be considered as a maintenance diet. Deer supplement this diet by eating (when available) acorns, fruits, and over-winter rosettes of perennial forbs (table 1).

A knowledge of the chemical composition of deer foods is not sufficient, however, to determine their true values. To fully evaluate the results of chemical analyses of browse species, the digestive coefficients of the various plant species should be determined (Forbes *et al.* 1941). This knowledge also is limited for foods eaten by deer in the Midwest. The use of artificial rumens and *in vitro* digestion may offer a solution to this problem (Short 1963).

[4] *Murphy, D. A., and Crawford, H. S. Wildlife foods and understory vegetation in Missouri's National Forests. Missouri Dep. Conserv. Tech. Bull. 4, 55 p. 1970.*

Table 1. — *Chemical analyses of some preferred winter deer foods in Missouri Ozarks*
(In percent)

Plant species	Protein	Fat	Fiber	Ash	C	P	K
Red cedar *Juniperus virginiana*	7.08	11.02	24.42	3.70	1.17	0.12	0.49
Dwarf sumac *Rhus copallina*	4.49	7.53	27.35	4.05	1.42	.10	.58
Smooth sumac *Rhus glabra*	4.71	6.75	25.25	4.90	1.68	.13	.90
Fragrant sumac *Rhus aromatica*	5.36	4.03	32.31	3.46	.71	.11	1.01
Low blueberry *Vaccinium vacillans*	4.39	4.16	36.66	2.26	.65	.08	.35
Sassafras *Sassafras albidum*	5.09	3.41	36.19	1.83	.53	.09	.30
Shortleaf pine *Pinus echinata*	6.68	6.98	23.55	2.55	.27	.12	.41
Aster (rosettes) *Aster* sp.	18.31	3.41	8.19	9.04	.89	.26	2.77
Goldenrod (rosettes) *Solidago* sp.	11.81	3.43	9.33	7.82	1.03	.18	.84

Quality of deer range is reflected in physical development and reproduction of deer. The body weight of fawns (Murphy and Coates 1966, Verme 1963), antler development of yearling males (Severinghaus *et al.* 1950, French *et al.* 1955), and reproductive rate of females (Cheatum and Severinghaus 1950) are indicators of range quality. Body weight of fawns (fig. 2) indicates several different qualities of range in the Midwest.

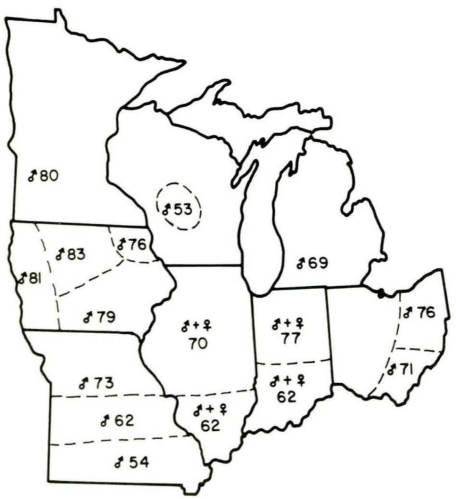


Figure 2. — Range quality in the Midwest as shown by body weight (Field-dressed) of fawns.

Different qualities of deer range within individual States also are indicated by the above criteria, and several States have divided their deer ranges accordingly (fig. 2). These divisions also generally correspond to other criteria for land classification, such as forest cover, soil type, and land use. The superior quality of foods in the Agricultural Range Class is demonstrated by higher average fawn weights and practically no yearling males with spike (unforked) antlers (table 2).

Table 2. — *Antler development of midwestern deer*

Area	Percent of yearling males with unforked antlers
Iowa (statewide)	Almost 0
Northern Illinois	0
Northwestern Ohio	0
Northeastern Ohio	0
Southeastern Ohio	0
Northern Missouri	3
Southern Michigan	5
Central Illinois	5-8
Central Missouri	12
Southern Illinois	21
Southern Missouri	21
Southern Minnesota	--
Southern Wisconsin	Varies annually

In Missouri, we theorized that the differences in physical development and reproductive rate were related to quality of forage as influenced by soil fertility.[5] However, analyses of browse plants from two

[5] *Dunkeson, R. L., and Murphy, D. A. Missouri's deer reproduction and check station data. (Paper presented at 15th Midwest Wildlife Conf., Chicago, 7 p. 1953.)*

regions with significantly different physical development of deer failed to reveal differences in chemical composition of the forage. We are now beginning to suspect that the observed regional differences may be related more directly to the amount of cultivated crops in the deer diet. Therefore, soil fertility is related to quality of deer range by its influence on land use.

NUTRITIONAL REQUIREMENTS OF DEER

This subject could be a symposium in itself, and I will not attempt to discuss it. A very good summary of the relationship of deer nutrition to deer range appraisal was presented by Dietz (1965). It should be recognized that a deficiency in any of the basic elements of nutrition can be as limiting to carrying capacity as can a quantitative shortage of food.

MEASURING VEGETATION AND CONDITION TRENDS

Dasmann (1948) classified range land surveys as (1) forage inventories, (2) range condition trends, and (3) forage utilization checks. This classification appears applicable to deer range appraisal in the Midwest. In other words, the deer range manager needs to know what is available, what is being used, and the effect of this utilization plus other influencing factors. Changes in vegetation occur slowly and subtly. Therefore, they are hard to measure, and even harder to demonstrate.

The methods reviewed by Dasmann (1948) were for California deer range, and few of them are applicable to the midwestern deer range. More applicable to our area are some of the methods of measuring understory vegetation discussed at a symposium in Georgia (USDA Forest Service 1959). The "in-depth" discussions at the symposium illustrate the fact that I can merely scratch the surface of measuring techniques in this paper.

My survey of the Midwestern States indicated that direct methods of range appraisal are not being applied in most of the nonyarding area. Most of the States seemed to be relying on indirect methods, such as harvest data, highway kills, crop damage complaints, or physical measurements of the deer herd. Calhoun reported that range condition studies in Illinois have proved of little value.[6] This statement appears to apply throughout the corn and soybean deer range.

[6] *Personal correspondence with J. C. Calhoun, Ill. Dep. Conserv.*

Forage Inventories

Dalke (1941) used the clip-and-weigh method for determining browse production in three cover types in Missouri. Ehrenreich and Murphy (1962) used the double sampling method (Wilm *et al.* 1944) in surveying deer forage production on National Forest lands in Missouri. The method proposed by Aldous (1944) proved applicable in Missouri Ozarks; it provided a basic knowledge of plant composition, species utilized, and degree of utilization in winter. However, the method proved too time consuming for statewide surveys. Data from the Aldous method indicated that only 10 species of plants were used consistently and heavily in winter. Therefore, we have been using belt transects and tallying only the major browse species as an index of browse utilization. The percentage of preferred species browsed is also a rough index of deer population densities (Murphy 1961).

Range Condition Trends

Bartholomew reported that exclosures had been established in Indiana, but the deer population had never reached a level where effects of utilization could be measured.[7] Exclosures were used by Dalke and Spencer (1944) in a study of overused deer range inside a fenced area in southern Missouri. The study indicated that appreciable improvement in range condition had not occurred even after 16 years of protection from grazing. Murphy used exclosures to measure effect of utilization on smooth sumac and elm in Missouri.[8] Dunkeson (1955) used the line-intercept method (Canfield 1944) to study trends in condition of forbs and shrubs browsed during summer in the Missouri Ozarks.

Forage Utilization

The "key area" concept of deer range appraisal in the yarding deer areas and mountainous areas of the Western United States is not applicable to the nonyarding deer areas. The "key species" concept appears to have more application. Dunkeson (1955) proposed that three shrubs which are browsed most of the year — New Jersey tea (*Ceanothus americanus*), wild hydrangea (*Hydrangea arborescens*), and wild grapes (*Vitis sp.*) — may be sensitive indicators of overutilization in Missouri's Ozarks. Deer practically eliminated wild hydrangea on the Crane Naval Depot in

[7] *Personal correspondence with R. M. Bartholomew, Ind. Dep. Natur. Resources.*

[8] *Murphy, D. A. Unpublished Pittman-Robertson report on file with the Missouri Dep. Conserv., Columbia, Missouri.*

Indiana.[7] Pietsch (1954) reported that all available sassafras and dogwood (*Cornus sp.*) were eliminated on an island in the Horseshoe Lake Game Refuge in Illinois.

Measurements of annual twig growth before and after browsing were used to determine degree of utilization and effects of utilization on preferred winter browse plants in Missouri.[8] Relating the amount of twig growth utilized to twig counts can be used also as a measure of browse production (Shafer 1963). This method needs further evaluation for use in midwestern deer range.

If game management is to progress in our increasingly complex society, we must develop game management from the art that it has been to a recognized science. The ability to measure accurately is basic to a science. In measuring forage production, we have the opportunity to advance towards scientific accuracy. The statistical approach should be utilized in experimental design, sampling, analysis, and interpretation of all forage measurements (Evans 1962). A competent statistician, preferably with biological training, should be involved in all phases of the project.

INFLUENCING FACTORS

Economics, land use, forestry practices, and biopolitics are some of the factors influencing the balance between deer populations and deer range. These factors are an intrinsic part of range appraisal. However, they also relate closely to management of deer range and will be discussed more fully by Dr. Crawford.

Woodland grazing by domestic livestock is an important influencing factor, especially in the Agricultural Range Class. Woods in this area are usually in woodlots or stream bottoms, and grazing by livestock is common. In Iowa, where 80 percent of the woodlands are pastured, 27 percent of the forest land is grazed so heavily that no tree reproduction is present and severe erosion occurs (Thornton and Morgan 1959). The percent of woodland pastured is shown for seven Midwestern States below:

State	*Percent of woods pastured*
Illinois	60
Indiana	36
Iowa	80
Michigan	15
Minnesota	—
Missouri	30
Ohio	36

Open range laws in Missouri have permitted grazing cattle and hogs on unfenced forest land. It was only recently that the laws were changed to prevent trespass grazing.

CARRYING CAPACITY

Determination of carrying capacity is the end product of deer range appraisal. Carrying capacity can be defined as the number of animals that a given unit of land area can support. In deer range management the phrase "without deterioration of the forage resource" must be added. Hosley (1956) reviewed carrying capacity of various ranges for white-tailed deer. He reported (p. 225), "Considering the wide range of conditions represented, there is a surprisingly close agreement in the carrying capacities reported. Twenty deer per section or a deer to 32 acres can be taken as an approximate average carrying capacity in the states represented."

A common approach to determining carrying capacity has been to permit the deer herd to increase, usually within a fenced area, until utilization of forage becomes excessive and reproduction and physical condition of the deer herd decline.

Some examples from the Midwest are: (1) Crane Naval Depot in Indiana — 50 deer per square mile eliminated wild hydrangea;[7] (2) Ravenna Arsenal in Ohio — one deer per 20 to 25 acres created a browse line;[8] (3) Fort Custer in southern Michigan — 100 deer per square mile created a browse line in hardwoods, and preferred species were heavily browsed or eliminated;[9] and (4) Drury Refuge in Missouri — 100 deer per square mile created a browse line on red cedar and decreased thrift and abundance of preferred summer browse species (Dunkeson 1955, Murphy 1961). Numerous other examples undoubtedly exist.

The above approach satisfies the first part of the definition of carrying capacity but does not consider the added phrase "without damage to the forage resource." These population densities actually represent a saturation level that exceeds the true carrying capacity of the range.

The true carrying capacity for deer in the Agricultural Range Class will probably never be reached except in isolated local areas. The tolerance of farmers to crop damage will be exceeded long before the deer herds exceed the food supply. In areas where landowners control large acreages, the tolerance level generally will be higher than in areas where landowners control small acreages.

The tolerance level of landowners may also reduce the carrying capacity of some local areas in the Northern Transitional Range Class. Damage to truck crops was among the most frequent complaints in Wisconsin and Minnesota. Farmers growing high-value crops on relatively small acreages are usually very intolerant of deer. Deer populations of 60 to 80

[9] *Personal correspondence with D. H. Jenkins, Mich. Dep. Conserv.*

per square mile of deer range in southern Wisconsin are at present creating excessive crop damage and creating hazards on highways.[10]

Acorns (when available) are a major part of the deer diet in the Central Hardwoods Range Class. The available food supply is increased substantially in years of acorn abundance. However, acorn production is unreliable and good yields do not occur every year. For this reason, I believe that carrying capacity of this range class should be based on yields of preferred native forage, and acorns should be considered only as a bonus in years when they are available.

Our survey of deer forage on National Forest lands in Missouri[4] showed the lowest production in winter, as might be expected. The annual carrying capacity therefore would be limited by the available food supply in winter. Only yields of preferred deer foods were used in calculating carrying capacity, and it was assumed that serious damage to preferred species would occur before other species were heavily used. An allowable utilization of 25 percent of the annual growth was set (other studies showed that this degree of utilization would not reduce the vigor of species involved). The conservative carrying capacity, as calculated using these considerations, was less than eight deer per square mile for the major forest types. The forest type with the widest distribution, black-scarlet oak (*Quercus coccinea*), had a carrying capacity of only three to five deer per square mile.

DISCUSSION AND RECOMMENDATIONS

When I accepted this assignment, I thought I could go to my reference files and find most of the material for the paper. It was quite a shock to find that very few published data were available. Perhaps some of my colleagues are guilty of not publishing their findings, but it appears that most of the basic data for deer range appraisal in the Midwest have not been collected.

The Lake States workers have concentrated their efforts on the problems of the yarding areas and have generally neglected the southern nonyarding deer ranges. Researchers in the Corn Belt States have apparently felt that deer range appraisal was not necessary. Attempts at deer range appraisal have progressed furthest in the oak-hickory forests of the southern part of the Midwest, but even there our knowledge is incomplete.

The absence of woody cover limits distribution of deer throughout much of the Midwest. There is every evidence that this cover will diminish in the future. An effort should be made to inventory present distribution of cover, measure the rate at which it is being depleted, and attempt to alleviate the depletion whenever possible.

Research on food habits has received attention in most of the Midwestern States. A knowledge of food habits is a basic first step in deer range appraisal, but the knowledge is worthless unless it can be applied to other steps in the appraisal.

It is the information on other factors essential to range appraisal that is generally lacking. Research is needed on forage production, effects of utilization, and trends in range condition.

Nutritional requirements of deer and the quality of forage should be studied. Quantitative shortages of food probably will not occur in the nonyarding deer range, but quality of range may restrict growth of deer populations.

Acorns and fruits of native trees and shrubs are important components of deer diets in the Midwest. Studies of the factors influencing production of these foods should be initiated.

Livestock grazing in woodlots can destroy their value for deer. Evaluations of this competition and recommendations for alleviating it should be made.

The recently adopted system of even-aged management in the oak-hickory forests will undoubtedly alter deer food production, and research studies of these changes should be undertaken immediately.

The white-tailed deer has demonstrated an amazing ability to adapt to apparent habitat deficiencies. However, if we are going to provide the number of deer required to meet demands of the ever-increasing number of hunters, deer range appraisal must be more complete and recommendations for range management more detailed. The techniques for securing most of the missing links are available, but manpower and financing must be made available to do the job.

[10] *Personal correspondence with G. F. Hartmann, Wis. Dep. Natur. Resources.*

LITERATURE CITED

Aldous, S. E. 1944. A deer browse survey method. J. Mammal. 25(2): 130-136.

Allen, J. M. 1955. White-tailed deer. p. 36-54. *In* Indiana Pittman-Robertson Wildlife Restoration 1939-1955. Indiana Dep. Conserv. P-R Bull. 3, 240 p.

Atwood, E. L. 1941. White-tailed deer foods of the United States. J. Wildlife Manage. 5(3): 314-332.

Canfield, R. H. 1944. Measurement of grazing use by the line interception method. J. Forest. 42(3): 192-194.

Cheatum, E. L., and Severinghaus, C. W. 1950. Variations in fertility of white-tailed deer related to range conditions. 15th N. Amer. Wildlife and Natur. Resources Conf. Trans. 15: 170-190.

Christisen, D. M., and Korschgen, L. J. 1955. Acorn yields and wildlife usage in Missouri. 20th N. Amer. Wildlife and Natur. Resources Conf. Trans. 20: 337-357.

Dahlberg, B. L., and Guettinger, R. C. 1956. The white-tailed deer in Wisconsin. Wis. Conserv. Dep. Tech. Wildlife Bull. 14, 282 p.

Dalke, P. D. 1941. The use and availability of the more common winter deer browse plants in the Missouri Ozarks. 6th N. Amer. Wildlife and Natur. Resources Conf. Trans. 6: 155-160.

Dalke, P. D., and Spencer, D. L. 1944. Development and land use on a private game preserve in southern Taney County, Missouri. J. Wildlife Manage. 8(1): 1-6.

Dasmann, W. P. 1948. A critical review of range survey methods and their application to deer range management. Calif. Fish and Game 34(4): 189-207.

DenUyl, D. 1962. The central region. *In* Regional silviculture of the United States. New York: The Ronald Press Co. p. 137-177.

Dexter, R. W., Cortese, S. J., and Reed, S. A. 1952. Analysis of food habits of white-tailed deer. Ohio Wildlife Invest., Dep. Natur. Resources 3(3): 34-39.

Dietz, D. R. 1965. Deer nutrition research in range management. 30th N. Amer. Wildlife and Natur. Resources Conf. Trans. 30: 274-285.

Dunkeson, R. L. 1955. Deer range appraisal for the Missouri Ozarks. J. Wildlife Manage. 19(3): 358-364.

Duvendeck, J. P. 1962. The value of acorns in the diet of Michigan deer. J. Wildlife Manage. 26(4): 371-379.

Ehrenreich, J., and Murphy, D. A. 1962. A method of evaluating habitat for forest wildlife. 27th N. Amer. Wildlife and Natur. Resources Conf. Trans. 27: 376-384.

Erickson, A. B., Gunvalson, V. E., Stenlund, M. H., and others. 1961. The white-tailed deer of Minnesota. Minn. Dep. Conserv., Tech. Bull. 5, 64 p.

Evans, T. C. 1962. Problems in forest habitat measurement. 27th N. Amer. Wildlife and Natur. Resources Conf. Trans. 27: 362-368.

Forbes, E. B., Marcy, L. F., Voris, A. L., and French, C. E. 1941. The digestive capacity of the white-tailed deer. J. Wildlife Manage. 5(1): 108-114.

French, C. E., McEwen, L. C., Magruder, N. D., and others. 1955. Nutritional requirements of white-tailed deer for growth and antler development. Penn. Agr. Exp. Sta. Bull. 600, 50 p.

Gysel, L. W., and Stearns, F. 1968. Deer browse production of oak stands in central Lower Michigan. USDA Forest Serv. Res. Note NC-48, 4 p. N. Cent. Forest Exp. Sta., St. Paul, Minn.

Hosley, N. W. 1956. Management of the white-tailed deer in its environment. *In* The deer of North America. Harrisburg, Pa.: Stackpole Co., and Washington, D. C.: Wildlife Manage. Inst. p. 187-259.

Jenkins, D. H., and Bartlett, I. H. 1959. Michigan whitetails. Michigan Dep. Conserv. 80 p.

Kline, P. D. 1965. Status and management of the white-tailed deer in Iowa, 1954-1962. Iowa Acad. Sci. Trans. 72: 207-217.

Korschgen, L. J. 1962. Foods of Missouri deer with some management implications. J. Wildlife Manage. 26(2): 164-172.

Murphy, D. A. 1961. Deer harvests from refuge areas in Missouri. Southeast. Assoc. Fish and Game Comm. Conf. Trans. 15: 37-42.

Murphy, D. A., and Coates, J. A. 1966. Effects of dietary protein on deer. 31st N. Amer. Wildlife and Natur. Resources Conf. Trans. 31: 129-139.

Nixon, C. M., and McClain, M. W. 1968. Deer and Ohio's forests. Ohio Woodlands 6(4): 27-28.

Pietsch, L. R. 1954. White-tailed deer populations in Illinois. Ill. Natur. Hist. Survey, Biol. Note 34. 22 p.

Severinghaus, C. W., Maguire, H. F., Cookingham, R. A., and Tanck, J. E. 1950. Variations by age class in the antler beam diameters of white-tailed deer related to range conditions. 15th N. Amer. Wildlife and Natur. Resources Conf. Trans. 15: 551-570.

Shafer, E. L. 1963. The twig count method for measuring hardwood deer browse. J. Wildlife Manage. 27(3): 428-437.

Short, H. L. 1963. Rumen fermentations and energy relationships in white-tailed deer. J. Wildlife Manage. 27(2): 184-195.

Thornton, P. L., and Morgan, J. T. 1959. The forest resources of Iowa. USDA Forest Serv. Forest Survey Release 22, 46 p. Cent. States Forest Exp. Sta., Columbus, Ohio.

USDA Forest Service. 1959. Techniques and methods of measuring understory vegetation. South. and Southeast. Forest Exp. Sta., Symp. Proc., 174 p.

USDA Forest Service. 1962. Timber management guide for upland central hardwoods. 33 p., illus.

Verme, L. J. 1963. Effects of nutrition on growth of white-tailed deer fawns. 28th N. Amer. Wildlife and Natur. Resources Conf. Trans. 28: 431-443.

Wilm, H. G., Costello, D. F., and Klipple, G. E. 1944. Estimating forage yield by the double-sampling method. J. Amer. Soc. Agron. 36: 194-203.

DEER POPULATIONS IN THE MIDWEST[1]

CHARLES M. NIXON
Ohio Division of Wildlife
New Marshfield, Ohio

ABSTRACT

Deer *(Odocoileus virginianus)* in the nonyarding portion of the Midwest, including all of Ohio, Indiana, Illinois, Missouri, Iowa, and the southern portions of Minnesota, Wisconsin, and Michigan, were nearly exterminated by 1910. Protection, improved habitat, and restocking provided the impetus for rapid increases after 1930. By 1968, there were nearly 850,000 nonyarding deer in the Midwest. Present populations are highest in central Wisconsin, central Minnesota, the Missouri Ozarks, and southern Michigan; they are lowest in the Corn Belt States of Ohio, Indiana, Illinois, and Iowa. Trends in highway deer kills since 1963-64 show that herds in Iowa and Minnesota are nearly stable while herds in the remaining States have been increasing between 10 and 20 percent per year. The nonyarding deer population in the Midwest will probably reach 1 million by the early 1970's. Continued destruction of deer habitat will cause deer populations to stabilize and begin to decline within the next decade.

This paper attempts to survey the present status of the nonyarding deer herds of the Midwest. I am restricting this discussion to the deer herds of Ohio, Indiana, Illinois, Missouri, Iowa, and the central and southern portions of Michigan, Wisconsin, and Minnesota. Winter weather seldom restricts deer movement in this range, and except for enclosed herds, refuge populations, and the southern Missouri Ozarks, an overpopulation of deer and associated range deterioration has never occurred. Deer densities are well below those of more northern herds, and large deer populations are a fairly recent phenomenon.

Less than 5 percent of this region is in public ownership, and intensive human utilization of most of the land for industrial or agricultural purposes creates conflicts with expanding deer herds. Queal's (1968, p. 51) statement, "Rural landowners can directly influence the management and harvest of deer in agricultural areas because of their attitudes toward deer and deer hunter access on their lands," is true for most nonyarding Midwest range.

I wish to acknowledge the cooperation of the following biologists who generously supplied information concerning the status of deer in their respective States: Richard Bartholomew, Indiana Department of Natural Resources; Dr. Richard Andrews, Eastern Illinois University; David Arnold, Michigan Department of Natural Resources; Dean A. Murphy, Missouri Department of Conservation; William Creed and George Hartmann, Wisconsin Department of Natural Resources; Paul Kline, Iowa Conservation Commission; and John Idstrom, Minnesota Department of Conservation.

HISTORICAL REVIEW

After settlement began, deer populations increased in much of the region as pioneer clearings temporarily improved deer habitat by opening the virgin forests (Pietsch 1954, p. 4). After 1860, however, the ever-expanding human population and concurrent removal of forest cover, along with year-round hunting, exterminated deer from all of Ohio, Indiana, Illinois, Iowa, and southern Michigan by the early 20th century. Only small scattered populations were present in southern Wisconsin and Minnesota and in the Ozarks of Missouri. In 1910, the Midwest population, exclusive of captive herds, probably totaled less than 2,000 deer.

Restocking, improved law enforcement, conservative hunting regulations, and reforestation of abandoned agricultural land combined to favor the reestablishment of deer. Restocking in the Corn Belt States was augmented by movement into unoccupied range from rapidly increasing adjacent herds (fig. 1). Deer moved south from Michigan into northern Indiana and Ohio (McNeil 1962, p. 29), from western Pennsylvania into northern Ohio,[2] from the Missouri Ozarks into central Illinois (Pietsch 1954, p. 7)

[1] *A contribution of Federal Aid in Wildlife Restoration Project, Ohio W-105-R.*

[2] *Chapman, F. The development and utilization of the wildlife resources of unglaciated Ohio. 1938. (Unpublished Ph.D. thesis on file at Ohio State Univ., Columbus.)*

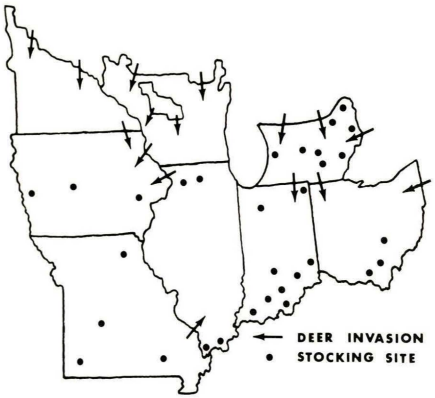


Figure 1. — Principal deer stocking sites and routes of natural restocking in the Midwest, 1920-1960.

and from central Minnesota and Wisconsin south into Iowa and Illinois (Sanderson and Speaker 1954, p. 615, Pietsch 1954, p. 9) (fig. 1). By 1940, at least 21,000 deer were present in the region, localized in the better coverts adjacent to stocking sites (table 1). Populations were largest in Minnesota, Wisconsin, Michigan, and Missouri, and this pattern has continued to the present.

Between 1940 and 1950, the amount of deer range increased considerably in each State. There were at least 80,000 deer in the region by 1950, occupying most of the available range (table 1). Crop damage complaints were increasing in portions of southern Michigan, northeast Ohio, Missouri, and Wisconsin. Highway kills were also becoming more frequent in every State in the region.

Even though liberal hunting regulations and relatively high cropping rates in Ohio and Indiana in the early and mid-1950's slowed deer population increases in these States, the Midwest herd increased to over 270,000 deer by 1960 (table 1). The Missouri herd, in particular, quadrupled in a decade.

Except for Illinois, deer herds continued to increase throughout the region during the 1960's, and by fall of 1968 the nonyarding range of the Midwest supported an estimated 845,000 deer (table 1).

PRESENT DISTRIBUTION

In general, present deer population densities in each State reflect land-use patterns and human population distribution (fig. 2). Deer populations are much higher in Missouri, Wisconsin, Minnesota, and Michigan than in the Corn Belt States. Average densities per square mile for each State show that Wisconsin leads with nearly eight deer per section, while Ohio and Illinois have the lowest densities, about one deer for each two sections (table 1). Deer are present in virtually every county in the Midwest, but

Table 1. — *Estimated prehunting fall deer populations in the Midwest, 1940-1968*

State	Area	1940	1950	1960	1968	Deer per sq. mile 1968
	(Sq. miles)					
Ohio	40,000	2,000	12,748	8,000	22,000	0.55
Indiana[1/]	36,291	800	3,000	17,000	40,000	1.10
Illinois[2/]	56,400	500	3,100	19,195	25,000	.44
Missouri[3/]	69,674	4,500	42,000	170,000	320,000	4.59
Iowa[4/]	56,280	1,000	4,500	22,468	38,000	.68
S. Michigan[5/]	22,300	5,000	15,000	30,000	80,000	3.59
S. Wisconsin[6/]	31,834	--	--	--	250,000	7.85
S. Minnesota[7/]	36,000	7,500	--	--	70,000	1.94
Total		>21,300	>80,348	>266,663	845,000	

1/ Allen (1950, p. 139); Crail (1954, p. 55); personal correspondence with R. Bartholomew, Ind. Dep. Natur. Resources.
2/ Pietsch (1954, p. 8, 11).
3/ Personal correspondence with D. Murphy, Missouri Dep. Conserv.
4/ Sanderson and Speaker (1954, p. 615); Kline (1965, p. 212); personal correspondence with P. Kline, Iowa Conserv. Comm.
5/ McNeil (1962, p. 12, 40); personal correspondence with D. Arnold, Mich. Dep. Natur. Resources.
6/ Personal correspondence with W. Creed, Wis. Dep. Natur. Resources.
7/ Erickson et al. (1961, p. 5); personal correspondence with J. Idstrom, Minn. Dep. Conserv.

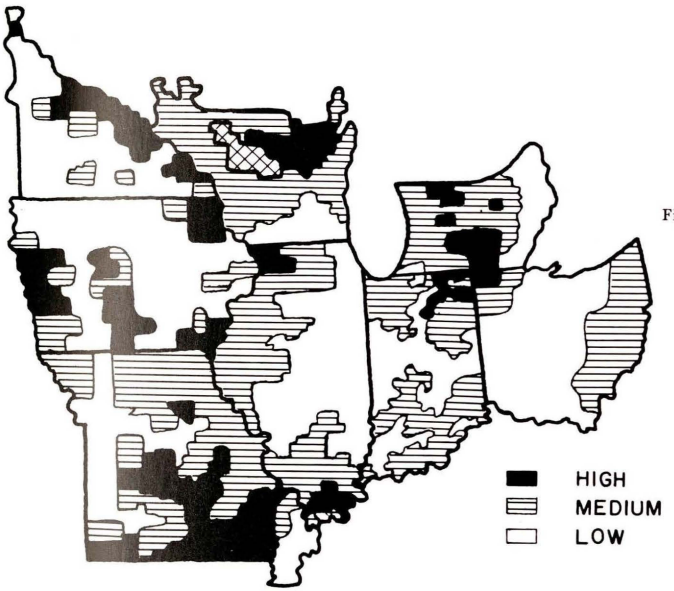


Figure 2. — Distribution of midwestern deer herds in 1968. Densities are comparable only within each State; i.e., high densities in Iowa do not compare with high densities in Missouri. The cross-hatched area shown in central Wisconsin represents central forest range and was not included in this survey.

local populations vary considerably from the statewide figures — from 60 to 80 per section in portions of Wisconsin to near zero in many counties in the Corn Belt (table 1).

RECENT TRENDS

Jahn (1959, p. 190) and Nixon (1965, p. 137) found annual highway deer kill useful as a means of showing population trends but not as a precise index of annual change. McNeil (1962, p. 24) also found the highway kill comparable with other indices of herd status.

A rate of population change may be estimated by linear regression using natural logarithms of the annual highway deer kill for a number of years if correction is made for the annual increase in highway construction and vehicular travel (McNeil 1962, p. 24). For Ohio, at least, highway traffic and new highway construction have been increasing about 2.5 percent per year and have been fairly consistent since 1953.[3]

[3] *Russell, K. Deer harvest patterns in Ohio. 1969. (Unpublished report on file at Ohio Div. Wildlife, Columbus.)*

The rate of change in highway deer kills shown in table 2 for each State is therefore slightly higher than the actual growth rate in each herd. On the basis of highway kill trends, the Minnesota and Iowa herds have been relatively stable since 1963-64, while the remaining herds have been increasing between 10 and 20 percent per year since that time (table 2).

MORTALITY

Mortality rates were calculated on the basis of fall population estimates and known mortality by various categories supplied by State conservation departments. Hunting is the leading cause of death in midwestern deer herds, followed by poaching, automobile collisions, dog predation, and miscellaneous deaths (table 3). States such as Illinois and Iowa that permit taking deer of either sex each fall and contain a limited amount of winter cover show the highest mortality (table 3). The rapid increase in the Missouri deer herd can be explained by the low annual mortality of this herd (table 3). Except for the Minnesota and Illinois herds, the mortality rates shown in table 3 seem to conform to the highway kill trends shown in table 2.

The slow increase in the Minnesota highway deer kill since 1964 would indicate that annual mortality

Table 2. — *Annual rate of increase in highway deer kills in the Midwest, calculated by use of natural logarithms (Loge) to compute linear regression*

State	Years	Rate of change	Deer population density
		(Percent)	(Rank)
Ohio	1963-67	+20.7	7
Indiana	1/1964-67	+13.3	5
Illinois	1/1963-67	+13.4	8
Missouri	1/1963-67	+18.1	2
Iowa	1/1963-67	+ 7.9	6
S. Michigan	2/1963-67	+15.1	3
Wisconsin3/	1/1964-67	+15.7	1
Minnesota3/	1/1964-67	+ 4.4	4
Average		+13.6	

1/ Thompson, F. Deer on highways, 1967 supplement. 1968. (Unpublished report on file at New Mexico Dep. Fish and Game, Santa Fe.)

2/ Arnold, D. Deer killed by cars, southern Michigan. 1968. (Unpublished report on file at Mich. Dep. Conserv., Lansing.)

3/ Highway kill for the entire State used because specific information for the southern portions was not available.

Table 3. — *Annual mortality rates for midwestern deer herds*
(In percent)

State	Harvest	Illegal	Highway	Dogs	Misc.1/	Total
Ohio	2/ 6.7	6.7	7.3	<1.0	<1.0	21-22
Indiana3/	4/10.5	10.5	1.5	<1.0	<1.0	23-24
Illinois5/	6/31.6	--	5.4	--	--	>37.00
Missouri7/	2/ 9.0	<1.0	<1.0	<1.0	<1.0	10-12
Iowa8/	6/30.0	10.0	3.0	<1.0	<1.0	43-44
S. Michigan9/	2/13.6	13.6	5.1	1.9	1.3	35.50
S. Wisconsin10/	2/25.2	<1.0	3.3	<1.0	<1.0	29-30
S. Minnesota11/	6/18.6	<1.0	2.3	<1.0	<1.0	22-23

1/ Train collisions, disease, fawn loss, fences, drownings, falls.

2/ "Hunter's choice" (deer of either sex) allowed in some portions of the State and "bucks only" in other portions.

3/ Personal correspondence with R. Bartholomew, Ind. Dep. Natur. Resources.

4/ Buck hunting only.

5/ Personal correspondence with J. Calhoun, Ill. Dep. Conserv.

6/ "Hunter's choice" statewide.

7/ Personal correspondence with D. Murphy, Missouri Dep. Conserv.

8/ Personal correspondence with P. Kline, Iowa Conserv. Comm.

9/ Personal correspondence with D. Arnold, Mich. Dep. Natur. Resources; McNeil (1962, p. 65).

10/ Personal correspondence with W. Creed, Wis. Dep. Natur. Resources.

11/ Personal correspondence with J. Idstrom, Minn. Dep. Conserv.

is higher than is shown in table 3. Based on the age structure of the southern Minnesota herd (Erickson *et al.* 1961, p. 21), an annual mortality rate near 40 percent would be needed to hold down population growth to the level shown by the highway kill. According to Andrews and Calhoun (1968), portions of the Illinois herd were overharvested beginning in 1965. However, highway kill trends for the entire State do not show a decline, although annual increases in highway kill have been small since 1966.[4]

The enclosed, protected herd on the George Reserve in southern Michigan can sustain an annual removal of 39 percent (Chase and Jenkins 1962, p. 78). Andrews and Calhoun (1968, p. 7) present evidence that a legal harvest greater than 35 percent resulted in an excessive mortality rate and subsequent population decline in one county in southern Illinois. If harvest management objectives include increasing the population, these data suggest that the legal harvest in nonyarding herds of the Midwest should not exceed approximately one-third of the fall population.

Poaching losses seem to be highest in the Corn Belt (table 3). High human densities and limited range combine to provide good poaching opportunity in these States. Poaching seems to be a definite deterrent to population growth in south-central Ohio and portions of southern Indiana where deer populations are low.[5] In the more northern herds of the Midwest and in Missouri, relatively high deer densities and more extensive deer coverts combine to limit poaching losses.

Deer collisions with automobiles are a serious problem throughout the Midwest. In portions of Wisconsin, Ohio, and Michigan adjacent to urban areas, highway kills may nearly remove the annual herd increment. At present, portions of Ohio, Illinois, Michigan, and Wisconsin have significant highway deer kill.

Dog predation is also a problem throughout the region, although direct mortality is probably low. Constant harassment by dogs can lower the carrying capacity of otherwise acceptable deer range. Except for the hound breeds, most farm dogs do not chase deer to the point of death. However, in portions of southeast Ohio and probably in many other areas, dogs frequent nearly all available deer coverts, often on a daily basis.

Parisite infestations or disease outbreaks do not seem to be a significant cause of mortality in midwestern deer. Chapman[2] reported a deer die-off from a *Clostridium* spp. infection in southern Ohio. Missouri and Michigan herds experienced die-offs from epizootic hemorrhagic disease in the 1950s (Fay *et al.* 1956, p. 173). The significance of the widespread serological evidence for leptospirosis in midwestern deer herds has not as yet been demonstrated, but a lowered fecundity caused by the disease is a possibility (Roth 1962, p. 145).

AGE COMPOSITION AND SURVIVAL

The age structure of midwestern deer herds as determined from deer shot by hunters indicates that few deer survive to 5 years. Fawns constitute about 40 percent of the fall population, and between 60 and 70 percent of most herds are less than 2 years old (table 4). Such an age structure indicates a high reproductive rate, and except in the Missouri Ozarks, most herds in the region are capable of nearly a 70 percent annual increase (Kline 1965, p. 212, McNeil 1962). Nearly 7 of 10 doe fawns conceive during their first year; virtually all adult does (1 year of age or older) conceive each year and usually carry twins.

Life tables constructed from fall-harvest data in four States in the region show that the average life expectancy at birth is less than 2 years (table 5). Deer that survive their first hunting season have a mean life expectancy of about 1.67 additional years (table 5). There seems to be a close similarity in overall survival throughout the Midwest if these samples are typical, although survival was somewhat better in southern Minnesota than in the Corn Belt States (table 5).

METHODS FOR ESTIMATING POPULATIONS

The use of sex and age ratios obtained from fall deer harvests for estimating deer populations has wide usage in the Midwest because large samples are easily obtained and annually available. However, cropping rates in each age class may not always reflect actual herd composition. There is evidence that deer less than 2 years of age are more vulnerable to shooting and accidents than older deer (Maguire and Severinghaus 1954, p. 98, Eberhardt 1960, p. 123, and Van Etten *et al.* 1965, p. 59). Fawn:doe ratios may change even during a single hunting season in response to varying levels of hunting pressure (Eberhardt 1960, p. 122), and sex ratios may also change if hunting seasons are set during and subsequent to the breeding season (White and Banasiak 1962).

The validity of fawn cropping rates may be examined by comparing fawn:adult-doe ratios in any year and the ratio of 1½-year-old does to 2½-year-old and

[4] *Thompson, F. Deer on highways, 1967 supplement. 1968. (Unpublished report on file at New Mexico Dep. Fish and Game, Santa Fe.)*

[5] *Personal correspondence with R. Bartholomew, Ind. Dep. Natur. Resources.*

Table 4. — *Age structure of five midwestern deer herds determined from fall harvest data*
(In percent)

State	Year	Fawn	Age			
			1-1/2	2-1/2	3-1/2	4-1/2+
Ohio[1]	1962-64	44.5	24.9	14.1	10.6	5.9
Illinois[2]	1957-66[3]	38.0	30.2	18.8	8.7	4.3
Missouri[4]	1951	39.0	23.0	22.4	9.4	6.1
Iowa[5]	1954-62	41.7	25.5	18.1	8.9	5.8
S. Minn.[6]	1956-57, 1959	41.1	25.9	14.8	9.7	8.4
Average	--	40.1	27.3	17.8	9.2	5.7

1/ Russell, K. Deer harvest patterns in Ohio. 1969. (Unpublished report on file at Ohio Div. Wildlife, Columbus.)
2/ Andrews and Calhoun (1968, p. 3).
3/ Pope County only.
4/ Brohn and Robb (1955, p. 14).
5/ Kline (1965, p. 213).
6/ Erickson et al. (1961, p. 21).

Table 5. — *Life table for four midwestern deer herds compiled from fall harvest data*

Year class	Iowa[1]			Ohio[2]			Illinois[3]			Minnesota[4]		
	l_x[5]	d_x[6]	e_x[7]	l_x	d_x	e_x	l_x	d_x	e_x	l_x	d_x	e_x
1/2	1,000	417	1.64	1,000	445	1.69	1,000	380	1.63	1,000	411	1.71
1-1/2	583	255	1.45	555	249	1.47	620	302	1.32	589	259	1.57
2-1/2	328	181	1.19	306	141	1.27	218	188	1.11	330	148	1.40
3-1/2	147	89	1.04	165	106	.92	130	87	.98	182	97	1.14
4-1/2	58	37	.86	39	59	.67	43	23	.96	85	54	.86
5-1/2+	21	21	.50	20	20	.50	20	20	.50	31	31	.50

1/ Kline (1965, p. 213).
2/ Russell, K. Deer harvest patterns in Ohio. 1969. (Unpublished report on file at Ohio Div. Wildlife, Columbus.)
3/ Andrews and Calhoun (1968, p. 3).
4/ Erickson et al. (1961, p. 21).
5/ Number of survivors per thousand.
6/ Number of deaths per thousand.
7/ Mean expectation of further life.

older does 1 year later (Eberhardt 1960, p. 35). Comparing these ratios indicates whether or not cropping has been consistent with age structure. Although year-by-year comparisons could not be made, the age structure of Iowa deer would indicate a cropping rate close to the actual age structure of the herd, because little difference was found between the fawn:adult-doe and yearling:adult-doe ratios (Kline 1965, p. 213). In northeastern Ohio for the years 1962-1964, fawn:doe ratios were much higher than yearling:adult-doe ratios, indicating too high a proportion of fawns in the kill in relation to actual numbers in the herd.[3]

Population densities of several herds have been estimated using the age structure of deer shot in the fall. If deer are harvested in proportion to their representation in the herd, then estimates based on following an age class to extinction may be useful in backdating population growth (McNeil 1962, p. 33, Andrews and Calhoun 1968). At least 5 years would be required in most midwestern herds. The accuracy of this method is also dependent upon accurate aging over several years and over a wide geographic area.

Direct counts of deer are in use only in Missouri and Ohio; both States use aerial censuses on selected

areas when snow conditions permit. Ohio also uses track counts made 24 to 48 hours after a fresh snow in selected townships scattered throughout the deer range. About 144,000 acres are checked each year, and at densities below five deer per section such counts are quite accurate. There has been close agreement between these counts and known reproduction and mortality in the study townships.

Landowner interviews are used in Missouri, and conservation officer estimates are solicited each winter in Indiana and Iowa to determine population status. At low densities (less than five deer per section) these estimates are good trend indicators, but at higher densities year-to-year changes may be difficult to detect unless they are drastic.

Indiana is presently the only State in the Midwest utilizing pellet counts in nonyarding range. Pellet counts have not been utilized to a greater extent in the region because: (1) The number of plots and manpower needs are prohibitively high at low deer densities, (2) low density estimates often produce confidence intervals greater than the mean estimate, and (3) in the southern portions of the region at least, heavy deciduous leaf cover and lack of snow make pellets hard to see and their age hard to estimate.

DISCUSSION

The high deer densities in Michigan, Wisconsin, Missouri, and Minnesota are the result of restrictive harvests, high deer productivity, favorable habitat, and a "protectionist" landowner attitude. Human tolerance of large deer herds can be high, even when crop damage is frequent, and extensive crop damage promotes more hunting opportunity because landowners desire higher deer kills and better herd control (Queal 1968, p. 68). However, in terms of human tolerance, deer herds in both Michigan and Wisconsin are approaching or have exceeded a maximum density for farmland range. Crop damage and collisions with automobiles are high in both States, and cropping rates, which thus far have lagged behind population growth, are being liberalized to reduce deer populations in problem areas.

Population control has not been a problem in the remainder of the region. Short "hunter's choice" seasons have usually been effective in controlling bothersome herds.

Populations in Ohio (Nixon 1963, p. 68), Indiana (Haller 1953) and Illinois (Andrews and Calhoun 1968) have lagged behind those in the remaining States because of high legal harvests during the 1950's in Ohio and Indiana and 1960's in Illinois, and because of high nonhunting mortality, chiefly poaching. At low densities poaching can be an effective population depressant (Crail 1954, p. 55). Deer populations are presently increasing in both Ohio and Indiana under more restrictive harvest regulations (table 1).

With an annual mortality rate of nearly 45 percent, the Iowa herd appears to have been relatively stable in recent years, for the annual mortality is nearly equal to the annual increment.

Missouri has one of the largest herds in the Midwest, and has in the sparsely populated Ozarks the best potential for even higher densities without the conflicting human activities that limit other herds. However, the present carrying capacity of much of the Ozarks is less than eight deer per section.[6]

In nearly all of the region, but particularly in Ohio, Indiana, Missouri, and southern Michigan, deer herds will continue to increase, at least for a few more years. The nonyarding deer population in the Midwest may well reach 1 million by the early 1970's. However, an ever-expanding human population in the region must soon begin to erase the range improvement that began accelerating nearly 40 years ago. Particularly in the Corn Belt, continuing woodlot clearing and construction of flood control structures are destroying deer habitat. From central Ohio through central Indiana and Illinois into the prairie and riverbreak range of Missouri and Iowa, forest cover is essential for deer survival.[7]

Even in the better deer coverts of the Midwest, land abandonment and reversion to brush and forest will not continue indefinitely. Deer populations must inevitably decline as forests mature and human activities destroy more range. In Ohio deer concentrations have shifted from northeastern Ohio to the southeastern hills in the past 15 years because of an elimination of habitat in northeastern Ohio. Because of human activities in northeast Ohio there is a significantly higher survival rate for southeast Ohio deer compared with deer from the northeast.[3]

Liberalized hunting, increased nonhunting mortality, and continued loss of habitat will, in all likelihood, at first stabilize and then begin reducing midwestern deer herds, probably within the next decade.

LITERATURE CITED

Allen, J. 1950. White-tailed deer investigations. Indiana Pittman-Robertson Invest. 11: 130-142.

Andrews, R., and Calhoun, J. 1968. Characteristics of a white-tailed deer population in Illinois. Illinois Dep. Conserv., Game Manage. Rep. 1, 8 p.

[6] *Murphy, D. A., and Crawford, H. S. Wildlife foods and understory vegetation in Missouri's National Forests. Missouri Dep. Conserv. Tech. Bull. 4, 55 p. 1970.*

[7] *Mustard, E., and Wright, V. Food habits of Iowa deer. 1964. (Unpublished report, Pittman-Robertson Project W-99-R-3, on file at Iowa Conserv. Comm.)*

Brohn, A., and Robb, D. 1955. Age composition, weights and physical characteristics of Missouri's deer. Missouri Conserv. Comm., Pittman-Robertson Project, Ser. 13, 28 p.

Chase, W., and Jenkins, D. 1962. Productivity of the George Reserve herd. Nat. White-tailed Deer Symp. Proc. 1: 78-86.

Crail, L. 1954. White-tailed deer investigations. Indiana Pittman-Robertson Invest. 15: 41-59.

Eberhardt, L. 1960. Estimation of vital characteristics of Michigan deer herds. Michigan Game Div. Rep. 2282, 192 p.

Erickson, A., Gunvalson, V., Stenlund, M., Burcalow, D., and Blankenship L. 1961. The white-tailed deer of Minnesota. Minn. Div. Game and Fish Tech. Bull. 5, 64 p.

Fay, L., Boyce, A., and Youatt, W. 1956. An epizootic in deer in Michigan. 21st N. Amer. Wildlife Conf. Trans. 21: 173-184.

Haller, F. 1953. White-tailed deer investigations. Indiana Pittman-Robertson Invest. 13: 1-20.

Jahn, L. 1959. Highway mortality as an index to deer population change. J. Wildlife Manage. 23(2): 187-197.

Kline, P. 1965. Status and management of the white-tailed deer in Iowa, 1954-1962. Iowa Acad. Sci. Proc. 72: 207-217.

Maguire, H., and Severinghaus, C. 1954. Wariness as an influence on age composition of deer killed by hunters. New York Fish and Game J. 1(1): 98-109.

McNeil, R. 1962. Population dynamics and economic impact of deer in southern Michigan. Mich. Dep. Conserv., Game Div. Rep. 2395, 143 p.

Nixon, C. 1963. Deer harvest analysis, 1959. Game Res. in Ohio 2: 60-69.

Nixon, C. 1965. The relationship between the annual accidental deer kill and the legal harvest in Ohio. Game Res. in Ohio 3: 137-152.

Pietsch, L. 1954. White-tailed deer populations in Illinois. Ill. Natur. Hist. Surv. Biol. Note 34, 22 p.

Queal, L. 1968. Attitudes of landowners toward deer in southern Michigan, 1960 and 1965. Mich. Acad. Sci. 53: 51-69.

Roth, E. 1962. Bacterial diseases of white-tailed deer. Nat. White-tailed Deer Symp. Proc. 1: 145-150.

Sanderson, G., and Speaker, E. 1954. Results of Iowa's first deer season in recent years. Iowa Acad. Sci. Proc. 61: 615-630.

Van Etten, R. C., Switzenberg, D. F., and Eberhardt, L. 1965. Controlled deer hunting in a square-mile enclosure. J. Wildlife Manage. 29(1): 59-73.

White, D., and Banasiak, C. 1962. Effects of kill density on deer harvest sex ratios in New Hampshire and Maine. 14th Northeast Wildlife Conf. Proc., 15 p.

MIDWESTERN DEER HABITAT

HEWLETTE S. CRAWFORD, JR.
Formerly Wildlife Ecologist, North Central Forest Experiment Station
Now with Southeastern Forest Experiment Station
Blacksburg, Virginia

ABSTRACT

Restocking of white-tailed deer *(Odocoileus virginianus)* in the Midwest has been conducted under conditions of optimum habitat. More intensive use of agricultural and wooded lands will change the habitat, and reduce the area that supports deer populations. Imagination, deviation from standard paths, and sound, meticulous research are needed by the wildlife profession to retain future habitat. It will be retained at the expense of agricultural or timber production. The landowner must be reimbursed if we expect him to forego raising other products to produce wildlife.

The purpose of this paper is threefold: (1) to discuss how past conditions of the habitat affected the range of white-tailed deer; (2) to evaluate how present and future land management changes will affect habitat and the range of deer; and (3) to evaluate measures that can be taken to offset future habitat deficiencies. I wish to thank the moderator, members of the panel, and Dr. Theodore Bookhout for reviewing this paper.

EARLY RANGE CONDITIONS

Since a period of low deer populations about the turn of the century, restocking and natural dispersion have extended deer range outward from a few remnant populations located in generally inaccessible forests into many wooded and agricultural areas throughout the Midwest. Restocking deer into agricultural areas was conducted at a time when the habitat was "ripe" — from the 1930's until the 1950's. Many farms had been abandoned during the droughts and depression of the thirties. Secondary succession on abandoned farms created good deer habitat (Beckwith 1954). On operable farms there were many uncropped areas, such as oak-hickory woodlots, wooded lanes, wide and brushy hedgerows, and wet, wooded bottoms that provided cover. The combination of crops interspersed with mature woodlands yielded year-round food — crops, weeds, and twig and leaf browse during the growing season; crop residue and hard and soft mast during the dormant season. Intense stocking and the interest and support of the local citizenry completed the requirements, and range of the white-tail was extended into agricultural areas over a relatively short time.

Habitat conditions within woodland areas at this time were also favorable for an increased deer herd. Many different oaks (*Quercus* spp.), hickories (*Carya* spp.), and other fruit-bearing trees and shrubs were present. Frequent burning maintained a relatively open understory, with a preponderance of native lespedezas (*Lespedeza spp.*) and other fire-tolerant legumes (Blakey 1937) providing good deer forage.

CHANGES IN AGRICULTURAL LAND

Beginning in the 1940's, the amount of "idle land" on farms began to decrease. The pace of putting idle lands into crops or pasture increased during the 1950's and 1960's in spite of surpluses and government land-retirement programs.

The farmer has been caught in a price squeeze. Costs of operation have gone up while the price received for farm products has not risen correspondingly. Heavy investment in equipment, supplies, and land make it mandatory that every acre produce the maximum or the farmer will not make a profit. Uncultivated land that has crop potential is a luxury he cannot afford. Consequently, hedgerows, woodlots, wooded bottoms, and other areas important to wildlife are being converted to cropland.

In the past, the farmer paid the costs of producing our wildlife. Now he is becoming a businessman concerned with investment input compared with profit output. Farm output per manhour increased 393 percent from a base period of 1940-44 to 1966 (Ackley 1967). Inefficiency has been recognized and is being corrected by small farms merging into fewer, more effective, larger units (Hillman 1967). More fences are eliminated as the farms change from a "few cows

and a few crops" to intensive one- or two-crop systems. Marginal sites become productive when they are fertilized or irrigated. These and other changes are contributing to the reduction of idle acreage and a loss of habitat.

In the next 10 years, agriculture will likely change more than it has in the past 20 years. Two-thirds of the world's people today are hungry. Demographers estimate that by 1985 the world's population will double. A recent book, *Famine, 1975!* (Paddock and Paddock 1967), attempts to show that world food needs will exceed the food supply by 1975, and that starvation will be rampant in many areas of the world. The authors point out that only four nations — Argentina, Australia, Canada, and the United States — will provide enough food suitable for export to the many starving, nonproducing nations, and only the U.S. will produce enough to exceed commercial export requirements.

CHANGES IN WOODLANDS

Many areas of woodland, particularly those on better soils, have been and will continue to be converted to cropland. Flood control programs on many river systems have inundated many acres of wooded deer habitat and also have limited seasonal flooding, making it possible to grow crops on areas that formerly could produce only timber. The remaining woodlands are generally growing on poor soils and steep or stony sites where crop potential is not great and crop production impractical. These woodlands have also changed since the time deer were originally stocked.

The first major change was caused by fire control. When frequent burning was stopped, hardwoods resprouted profusely. Many areas that formerly had desirable herbaceous understory vegetation and fruit-producing understory plants now support dense stands of saplings or poles with little understory vegetation.

Secondly, and probably of less importance, timber management recommendations have suggested the removal of noncommercial species, such as post oak (*Q. stellata* Wang.), or blackjack oak (*Q. marilandica* Muench.), from timber stands. This reduces the variety of mast-producing plants.

Impact of the third, and possibly most important, factor has not yet been felt on many private areas but will be more evident in the future. Even-aged management has been shown to be the best silvical system for growing oaks in the Midwest. This system requires regeneration accompanied by clearcutting, as opposed to the former system of selective cutting. Also inherent in even-aged management is a series of intermediate or thinning cuts.

At first glance, it seems this system would benefit deer range because it involves cutting that opens the stand. However, the response of the understory is affected by site quality and cutting intensity and results are not always beneficial. For instance, an intermediate cut on a poor site may yield only sprouts of oak species that have little food value for deer. On a poor site oaks sprouting from an existing root system could utilize all available moisture, light, or nutrients to the detriment of other species that do not have the advantage of an existing root system.

Management on better sites retained in timber will be more intensive in the future. Superior-growth trees will be planted and grown, with little or no competition either in the overstory or understory. Trees with superior growth characteristics may have inferior fruiting characteristics, and fruit growth might well be suppressed because it utilizes nutrients and water that could go to production of cellulose. A timber stand without fruit production and devoid of understory vegetation has little value for deer.

Not even poor timber sites where it is uneconomical to conduct intensive silvical practices are exempt from change. Millions of acres of poor-site hardwoods are being converted to grassland. The practice is increasing each year as the demand for beef increases and as farmers learn they can greatly increase their return from the land by growing grass instead of scrub timber. A recent study (Crawford and Bjugstad 1967) has shown that 2 tons per acre of native bluestem (*Andropogon* spp.), switch (*Panicum virgatum* L.), or indian grass (*Sorghastrum nutans* L.), or approximately the same amount of Kentucky-31 fescue (*Festuca arundinacea* Schreb.) can be grown on formerly wooded areas having a site index of 55 for black oak. On droughty south and west slopes with site indexes from 35 to 45, native grasses will yield from 1 to 1½ tons; fescue will not do as well.

Patchwork conversion of small acreages could enhance deer habitat by creating diversity, assuming lands were not heavily grazed; however, large ownerships are often completely converted. Thorough conversion and heavy grazing over large, contiguous ownerships will decrease food and cover for white-tailed deer.

On marginal agricultural soils some formerly cultivated land has reverted to woodland. However, part of the reported increase in forest land is actually an increase in brushy pasture or rangeland. For instance, in Missouri about 25 percent of the reported commercial forest land is less than 10 percent stocked with trees and is used to graze cattle (Bjugstad and Crawford 1967).

RETAINING DEER HABITAT

Food needs and technological change of the future are certain to have a substantial impact on the Midwestern United States. This region, one of the most

fertile agricultural areas in the world, contains the Corn Belt, which produces more than 40 percent of the world's corn (Woytinsky and Woytinsky 1953), and the eastern winter wheat belt, a major soft-wheat-producing area. Production, preference, storage, and transport characteristics determine that wheat and corn will be our major exports in attempting to meet the world's food needs. Technological change will continue to increase yields and make it profitable to put more land into agriculture. Rising domestic incomes, growing exports, and new farm policies that more effectively relate production to demand have almost eliminated government surplus (Ackley 1967, Paddock and Paddock 1967) and insure a continuing market.

Less-fertile areas, such as former croplands that have reverted to brush or old fields, will be in demand for food production. Beef-cattle production will increase on these areas just as it is increasing on poor soils where woodland is being converted to pasture and range. Newer, more adaptable pasture plants, such as Kentucky-31 fescue, which respond well to fertilizer and withstand intensive use, are being successfully planted to make productive pastures.

In short, we will be hard pressed to retain any land with agricultural potential for wildlife production with present land management practices. There may be a wealth of summer food and cover, but once crops are harvested little food or cover will remain for deer. The same will probably be true for other game species.

There are two opportunities for retaining deer habitat: (1) modification of agricultural practices, and (2) maximum enhancement of habitat on wooded lands with little agricultural potential. Economics will determine if either or both are possible.

World food requirements will not dictate that wildlife cannot be grown. In our free enterprise system the man who makes his living from the land can grow wildlife instead of wheat or corn if he prefers — but wildlife must pay a return if he is to forego raising agricultural products. Here is the crux of the problem: in the past the farmer has received little or no return from wildlife, but, intentionally or unintentionally, has paid the cost of producing it. Present trends indicate that if the farmer does not receive a monetary return in the future, he will not produce wildlife because of the strong demand for and profit in crop production.

Deer production on wooded areas will be competing with intensive timber production, intensive recreational development, or in some cases, with watershed protection. Additionally, there is the possibility that woodlands will be converted to grass and managed for cattle. In woodlands, just as in cropland, the use that shows the greatest economic return will stand the greatest chance of dominating. I am speaking of privately owned land because the area of public land in the range of nonyarding deer in the Midwest is small compared with the total land area. However, the principle that the use that brings the greatest economic return will dominate may likely apply to public land in the future, and does so now on many public lands.

What steps should we take to retain deer habitat? First, we must modify our thinking on "free" use of the game resource. Someone pays for game production, but our inherited philosophy makes us reluctant to think that the consumer should pay the producer. In the future of the Midwest, the producer will seldom pay for game production; if the consumer refuses to pay, there will be little game.

Another philosophical breakthrough that must be made is placing a monetary value on the wildlife resource for economic comparison. We have to be able to relate the value of a deer herd to the value of corn, timber, or any other competing land use. The comparison is best when direct, and although dollars provide a direct unit of comparison, there has been a past reluctance to assign a dollar value to wildlife because of its intangible value. The intangible value must not be ignored; it must be quantified.

The third step necessary to retain deer habitat is intensive habitat development. Woodlands, where the economic return from wood production is large, will be managed intensively for wood with little left for deer habitat. However, many wooded areas throughout the Midwest will not produce a satisfactory profit from growing wood (Ehrenreich and Ralston 1963, Sherman 1967). With proper management, these areas may produce a more valuable wildlife crop; or, the wildlife crop in conjunction with the timber crop may provide the greatest return. We have to determine the costs of various habitat improvement measures, the economic return expected from increasing deer production on any given area, and the return or loss to wood production.

Any agricultural areas set aside for wildlife production must be managed intensively for wildlife or there is no economic justification for removing it from crop production. We must determine the best way to develop and manage this land. The prime need in agricultural areas will be winter cover.[1] We must determine what cover conditions can support the greatest number of deer. Food needs seem less important but will be affected by efficiency of new harvest systems. The grain and cob of corn are primary

[1] *Mustard, E. W., and Wright, V. Food habits of Iowa deer. 1964. (Unpublished manuscript, Pittman-Robertson Proj. W-99-R-3, on file at Iowa Conserv. Comm.)*

winter foods of deer in the Midwest (Korschgen 1962, Watt *et al.* 1967). If new techniques eliminate crop loss in harvest, as they likely will, deer will depend more upon available crops, such as winter wheat. This dependence will not be at all compatible with farming. An increased supply of natural winter foods, such as acorns and coralberry (*Symphoricarpos orbiculatus* Moench.), will become more important.

The retention of habitat for nonyarding deer in Midwestern United States presents a challenge to the wildlife profession. It will require imagination, deviation from standard paths, and sound, meticulous, nonspectacular (but vital) research. We have to put a sound, acceptable value on deer and see that the landowner receives a return from his wildlife crop. We must determine how to improve the habitat, and show the landowner how these changes will benefit him financially.

I have assumed that the midwestern deer hunter is interested enough in his recreation to pay for it just as he would pay for a day on the golf course. If he is not, then chances are good that he will have to find a different form of recreation or be willing to travel greater distances to hunt.

LITERATURE CITED

Ackley, G. 1967. U.S. economic developments and policies and their impact on agriculture. J. Farm Econ. 49: 1019-1031.

Beckwith, S. L. 1954. Ecological succession on abandoned farm lands and its relationship to wildlife management. Ecol. Monogr. 24(4): 349-376, illus.

Bjugstad, A. J., and Crawford, H. S. 1967. Cattle in the woods or woods in the pasture. USDA Forest Serv. Res. Note NC-23, 2 p. N. Cent. Forest Exp. Sta., St. Paul, Minn.

Blakey, H. L. 1937. The wild turkey on the Missouri Ozark range. USDA Bur. Biol. Survey, Wildlife Res. and Manage. Leaf. BS-77, 32 p.

Crawford, H. S., and Bjugstad, A. J. 1967. Establishing grass range in the Southwest Missouri Ozarks. USDA Forest Serv. Res. Note NC-22, 4 p. N. Cent. Forest Exp. Sta., St. Paul, Minn.

Ehrenreich, J. H., and Ralston, R. A. 1963. Forage and timber production alternatives on shallow soils in the Ozarks. Soc. Amer. Forest. Proc., p. 80-83.

Hillman, J. S. 1967. Food and fiber policy for a changing agriculture J. Farm Econ. 49: 1057-1070.

Korschgen, L. J. 1962. Foods of Missouri deer with some management implications. J. Wildlife Manage. 26(2): 164-172.

Paddock, W., and Paddock, P. 1967. Famine, 1975! America's decision: who will survive. 276 p. Boston: Little Brown.

Sherman, R. W. 1967. Economics of sawtimber production in Appalachia, Ohio. Ohio Agr. Res. and Develop. Center, Res. Circ. 152, 38 p.

Watt, P. G., Miller, G. L., and Robel, R. J. 1967. Food habits of white-tailed deer in northeastern Kansas. Kans. Acad. Sci. Trans. 70: 223-240.

Woytinsky, W. S., and Woytinsky, E. S. 1953. World population and production: trends and outlook. 1268 p. New York: Twentieth Century Fund.

HARVEST REGULATIONS AND POPULATION CONTROL FOR MIDWESTERN DEER

DAVID H. JENKINS
Michigan Department of Natural Resources
Lansing, Michigan

ABSTRACT

In 1967, 149,000 deer were harvested by 629,000 hunters on 399,000 square miles of midwestern "farmland" deer country (in Minnesota, Wisconsin, Michigan, Ohio, Indiana, Illinois, Iowa, Missouri, and Nebraska). In this region, both hunting pressure and deer kill have increased recently. Deer populations on the average range from nearly zero to 5 deer per square mile, with concentrations up to 100 animals per square mile.

Antlerless deer are legal in all States in generally short seasons of different kinds. Shotguns are the legal weapons in most States. In 10 years, almost 1 million deer have been taken (54 percent antlered, 46 percent antlerless). Kill data are obtained by several methods — checking stations and mail surveys mainly.

Illegal kill and landowner-hunter relationships are problems, but serious only locally. Deer managers are generally satisfied with their authority.

Farmland deer are highly productive. To capitalize on this productivity demands landowner-hunter cooperation, controlled hunting pressure, and an adequate annual kill.

What do we mean by population control? In farm country the major means by which white-tailed deer (*Odocoileus virginianus*) populations are controlled are legal hunting, in-season illegal kill, poaching out of season, automobile-deer collisions, fawn mortality, and predation and harassment by dogs. We are concerned here mainly with a discussion of legal hunting because the information available on all of the other losses does not appear to be dependable, comparatively speaking. I have not included data on archery hunting because archers do not make much of an impact on the deer herds in farmland country. The rule to follow in establishing archery regulations is to set up the most liberal regulations possible because the inherently low success rate of archers in itself provides enough protection for an established herd. Further in my opinion, there is no good reason for denying a gun hunter a chance to kill a deer even though he managed to kill one in an earlier bow and arrow season. This chance to kill a second deer is legal in several States and it tends to boost the sport of archery.

This paper is, for the most part, based on information supplied by nine State agencies in response to a questionnaire sent out in the summer of 1968. Information available from the several States doesn't mix very well, and I've ended up with a "windshield survey" of hunting seasons. Data on the deer, the deer range, and the deer hunter for the northern parts of Minnesota, Wisconsin, and Michigan are much more complete than for the southern farmland range. This is natural because much research has been restricted to the large northern herds in these States, while fact-finding projects on the southern herds are relatively new. However, States such as Missouri, Iowa, and Nebraska, with rapidly growing farmland herds, have accumulated a wealth of good data.

When many of us think of deer hunting in the Midwest, we tend to think of the red-coated army headed north into the big woods a day or so before the season — wild-eyed and loaded down with 2- to 3-inch-long cartridges, a case or two of refreshments on the back seat, knives at the ready on the belt, up before dawn in a snow-covered cabin, and out along a cedar-balsam swamp edge, hoping for a crack at a big swamp buck. And you would be right. In spite of the fact that the midwestern nonyarding deer habitat covers almost 400,000 square miles in the lower third of Minnesota, lower half of Wisconsin, and lower half of Michigan, plus all of Ohio, Indiana, Illinois, Iowa, Nebraska, and Missouri, the northern deer range in Minnesota, Wisconsin, and Michigan still provides the most venison and the most recreation — a 1967 legal take of 254,000 deer by 1,017,000 hunters (about 7 hunters per square mile) on 136,000 square miles. This compares with 149,000 deer taken by 629,000

hunters (1½ per square mile) on 399,000 square miles of farms, woodlots, and subdivisions. But, if present trends continue — if the sun keeps shining down and producing wood in the northern forest areas faster than the trees can be cut down, and unless the land can be put back into something resembling deer country instead of a land of porcupines, woodpeckers, and red squirrels — many of us here now might see the day when the farm country deer harvest will outstrip that of the North Woods. Fifteen years ago in Michigan's farm country, 17,800 hunters killed 1,280 bucks, while in the famed Upper Peninsula, 96,400 hunters took 19,260 deer. Last year farmland hunters numbered 105,100 compared with 104,000 in the Upper Peninsula, and their kill was 10,400 deer compared with 24,700 above the Straits. But this 24,700 included 14,000 antlerless deer taken under much-liberalized hunting regulations. Comparative buck harvests tell the story more accurately. The Upper Peninsula buck take fell from 19,260 in 1952 to 17,800 in 1962, and to 10,700 in 1967, while the farm buck harvest climbed from 1,280 to 5,540 in the same years (Bennett *et al.* 1966, Ryel 1968). Something similar can be seen in Wisconsin, but the Minnesota situation seems to be more stabilized.

Public hunting land in the farm country covers only 2 percent of the total land area — 8,256 square miles — compared with 27 percent (29,000 square miles) of the total land area in the northern deer range of Minnesota, Wisconsin, and Michigan. This means, for all practical purposes, deer hunting in the farm country is a private land affair.

People we do have — 47 million of them in the farmland deer country, and they own and operate 25 million vehicles. Twenty-eight million of them live in the cities and suburbs. And 19 million share their land with almost 1 million deer. Censusing deer in farmland habitat is vexing, at best. I think in this respect there is only one "smart" State — Ohio. They say, "We never attempt to arrive at a deer population figure."

There is very little fee hunting for deer — where a landowner charges to hunt deer on his property. Most States report none. Nebraska reported that about 10 percent of their land was under fee hunting and the practice was growing. Missouri also reported about 10 percent of their deer range was under fee hunting, mostly near the metropolitan areas. Wisconsin has two such tracts covering 60,000 acres, one being a group of farms.

In 1967, the 629,000 farmland hunters were not evenly distributed within the region, nor within any State. Wisconsin led with 200,000. Here farmland hunters made up 42 percent of all license buyers. Of the three northern States, Michigan was next with 105,000 hunters. In Minnesota, where deer hunting is still a northern phenomenon, only 18,000 are farm country hunters. Missouri, with 162,000 hunters, stands alone and high among the other States. Illinois, Nebraska, Ohio, Iowa, and Indiana each have from 22,000 to 46,000 hunters. The three northern States determined hunter distribution by postcard surveys of a sample of license buyers. I asked the nine States how many hunters hunted in their farmland deer habitat, and three replied, "All of them." I suppose they took it for granted that we knew exactly what "all of them" meant numerically.

Some idea of hunting pressure in the northern deer range can be obtained by dividing the number of hunters per county or management area by its area in square miles. Farm country is different, and a general figure is meaningless because there are large blocks of land where no one hunts adjacent to areas where there are 20, 40, 80, or 100 hunters per square mile. Missouri reports 200 "nuts" per square mile on a refuge. Other States can boast of similar examples. A few years ago at Fort Custer in southern Michigan, between 700 and 800 individuals spent at least some time on a 2-square-mile area on the opening day of the season. There were no human casualties and, actually, few deer casualties, although any deer surviving something like that should be retired along with the ducks that complete their 25 missions at a shooting preserve!

Concentrations of hunters coincide fairly well with concentrations of deer. Every State reports general farmland deer populations from an average of nearly zero to 5 per square mile, and almost every State has concentration areas with populations of 20 to 50 deer per section with a few areas running up to 80-plus per square mile. Winter concentrations of over 100 deer in a 20-acre cornfield or orchard are not uncommon, to the dismay of the landowners. Also, concentrations of 5 to 20 deer per 100 feet of a two-lane highway are not uncommon, to the dismay of the motorist, as he speeds over the crest of a hill and sees them in front of him.

Every time I review the hunting regulations for any group of States, I am amazed at the provincialism of all of us. Here are nine contiguous States, yet there are major differences in the hunting regulations among almost all. Doesn't that mean something to us? Doesn't it raise questions in our minds as to just how *necessary* some of our regulations are? If something is absolutely necessary in northern Ohio, why isn't it necessary in southern Michigan? And if something is totally unnecessary in southern Wisconsin, why isn't it totally unnecessary in northern Iowa? Sometimes we're forced into silly regulations by our legislatures, or by the public, but are we sure we don't bring it upon ourselves sometimes?

Now, considering only farmland deer hunting regu-

lations—*Minnesota* has its traditional hunter's choice seasons, with short 1- to 5-day seasons in different zones, opening simultaneously, no limit on the number of hunters.

Moving next door to *Iowa* — hunter's choice seasons with the necessary control lying in the number of licenses available and the length of the season in different zones. Two- to 3-day seasons. Licenses issued first-come, first-served until the quota is filled. Resident hunting only.

Southern *Wisconsin* is zoned with 2- to 5-day hunter's choice seasons, plus a later bucks-only season in one of these zones, plus a 9-day buck season and its concurrent antlerless deer hunting by permit-holding parties of four hunters in other areas.

Across the lake in *Michigan:* A 16-day buck season in which permittees may take a deer of either sex in one of several areas. A drawing is held to determine who the permittees shall be.

Ohio: Zones with 4- to 6-day seasons, bucks only with one hunter's choice area in 1968.

Indiana has a 17-day buck season, plus special any-deer hunts on certain military reservations. In some areas hunters may take a second deer.

Illinois: A hunter's choice season in two 3-day periods with 10 days of closed season in between. Resident hunting only.

Missouri: A 4-day season for bucks in some counties and hunter's choice in others, followed by a 10-day closed period, then a 1-week bucks-only season.

Finally, to *Nebraska,* where some zones had a 9-day bucks-only season in 1968, plus some hunter's choice areas and times. All permits are issued under a quota on a first-come-first-served basis.

With the exception of firearms used, hunting regulations in Minnesota, Wisconsin, and Michigan are generally the same for farmland deer as they are for northern deer. With two exceptions (Nebraska and Missouri), the farmland area is shotgun and muzzle loader country. Nebraska insists on rifles only, with a minimum of 900 foot-pounds of energy at 100 yards. They also permit the magnum handguns, plus the old favorite .44. Missouri permits center-fire rifle bullets of not less than 60 grains, plus 20- to 10-gauge shotguns with slugs, and handguns .38 caliber or larger. Twenty-two caliber rim-fire rifles are finally taboo everywhere, and that's progress. Iowa, Illinois, Indiana, Ohio, and Wisconsin say shotguns with slugs only, and Indiana insists on 12-, 16-, or 20-gauge slugs only. Michigan permits slugs or buckshot. Wisconsin adds to the head scratching by insisting in one area it shall be shotguns only on November 23 and 24, but in the same area allows rifles from November 25 to December 1. There *must* be a good reason for this.

The rise of the use of muzzle loaders is refreshing. All nine States permit their use. Missouri, Illinois, and Ohio say they have to be .38 caliber or larger. Nebraska says .40 caliber or larger, Michigan says .44 caliber or larger, and Indiana says .45 caliber or larger. And Iowa says at least .44 but not larger than .775 caliber. They permit no cannonballs in Iowa. Wisconsin and Minnesota both say .40 caliber or larger if the barrel is rifled; .45 caliber or larger if it is a smooth-bore muzzle loader.

It seems to me that keeping the rural residents and schoolbus drivers happy and unafraid is the only good reason for the shotguns-only regulation. In Michigan, and I suspect other States would find the same, 85 percent of all deer hunting gun accidents occur at ranges less than 100 yards (well within range of a 12-gauge slug). Sixty-five percent of the accidents occur at ranges less than 50 yards, at which distance size 0 buckshot will do more than raise a welt on you. And 50 percent of our accidents occur within range of a bean shooter (10 yards).

In general, midwestern farmland deer populations are on the rise, and hunter participation and kill reflect the increase. The *average* annual regional harvest over the past 10 years is in the neighborhood of 90,000 animals. The 1967 total kill of 149,000 animals tops this appreciably. The entire picture in Minnesota and Ohio seems to be stabilized, but in all other areas an upward trend is noticeable. Not in a straight line, in all cases, but upward.

Hunter success varied considerably in 1967, from 70 percent in Minnesota, 56 percent in Nebraska, 36 percent in Iowa, and 30 percent in Wisconsin down to 10 to 14 percent in Illinois, Indiana, Missouri, and Michigan, and further down to 5 percent in Ohio.

Sex and age information on the deer killed in all States is not complete. But over the past 10 years in the region the kill has averaged something like 54 percent antlered bucks and 46 percent antlerless deer, and that is remarkably good. We in Michigan have a long way to go even to catch up to that regional average. In the past 10 years in our farm country, 10 percent of the kill has been antlerless deer. We are trying to correct that, but it's slow.

How the kill figures are determined and the pros and cons of the different systems currently used are grounds for a symposium in themselves. Briefly, there are about as many systems in the region as there are States. Ohio, Illinois, and Wisconsin man compulsory checking stations. Missouri does the same for their any-deer areas but depends on tag returns for the bucks-only areas. Iowa depends on a 95-percent return of hunter report cards. Nebraska has "compulsory" report cards with reminders to nonrespondents. Minnesota has a postcard sample survey. Indiana has a hunter report card system, but states that only one-third of the hunters comply. Michigan has a postcard sample survey with many followup

reminders. Obviously, the systems are dictated by what *we* think is best, our resources, custom, and what our legislatures make us do.

The major drain on the farmland herds is legal and illegal killing of deer. One especially hazy area is the illegal kill, which can be divided into two classes: In-season, accidental and otherwise, and out-of-season poaching. Objective data on these losses are not available except perhaps on small areas, and extrapolation could be misleading and perhaps totally inaccurate.

Minnesota says its illegal kill probably is not serious, but there are no quantitative data. Missouri, also, is not too concerned and places this loss at less than 1 percent of the herd. Wisconsin says illegal kill is bad locally but not statewide. Locally, it amounts to perhaps 10 percent of the fall herd. Wisconsin uses a crippling and illegal loss figure of 25 percent of the legal kill. Ohio believes that the illegal losses make up 10 to 12 percent of the herd's losses in most areas. In south-central Ohio illegal kill is estimated at about 50 percent of all herd mortality. Nebraska says it is bad when the herd is low, but they have no data. Illinois says it is serious locally, but again no data. Iowa considers illegal kill serious, perhaps 2,000 to 3,000 deer per year. Michigan says it is equal to 50 to 100 percent of the legal kill. Indiana states that illegal kill is a major limiting factor to the herd, possibly exceeding all other losses.

Obviousy we know very little about this potentially large loss to the herd. Herein lies one of our major unknowns. What to do about the illegal kill? Maintain as liberal regulations as possible. In farm country, especially, most deer should be legal targets if population levels are adequate.

Are farmer-deer hunter relations an obstacle to establishing good hunting regulations and good deer management? In a word, no. No State reported that trespass problems were serious enough to interfere with management plans, although there were several hotspots reported, especially near population centers. The generally short deer season compared with longer small game seasons makes for a shorter period of farmer anguish, and law enforcement effort can be concentrated. This appeals to many landowners. On the other hand, the short deer season in many States, especially those without the buffer of a more important northern season, concentrates the "madness." Further, the property line ignoring of northern deer hunters does not go over too well with the southern landowners when hunters bring their northern free-ranging habits down into farm country. Gang hunting on isolated plots of cover irritates landowners. Where public and private land is closely mixed, problems arise when hunters either do not recognize the boundaries or do not respect them. A Wisconsin survey showed 24 to 30 percent of farmland was posted against deer hunting.

As the concept of payment for hunting rights gains more acceptance, the landowners will accept hunters more graciously. I support Crawford's thesis (this conference) that the landowner will come to expect a dollar payment for granting permission to hunt. There are direct and indirect signs of this in many States. Obviously, the average landowner will not be able to raise a resident herd of deer like a flock of pheasants or rabbits or quail, but providing attractions for deer plus providing a good place to hunt will be worth more and more and there will be a market for this "product of the land."

Two comparable studies in Michigan in 1960 (McNeil 1962) and 1965 (Queal 1968) revealed significant changes in landowner attitudes concerning deer hunters as the deer herd increased. In 1960, 35 percent of landowners granted permission to hunt. This compared to 52 percent 5 years later. There were significant differences between farmers experiencing crop damage and those who did not. There was also a direct correlation between the numbers of deer seen by farmers and their granting hunter access. Also, where human population is high, granting permission to hunt is low. Naturally, permission to hunt was more easily obtained in the antlerless deer hunting areas in southern Michigan where there is a higher deer population, more crop damage, and more deer seen by landowners.

Are farmland deer managers happy with their lot, with their progress, and with their authority? Generally, yes. And this alone is something worthy of note. Iowa feels that the farmer's free license to hunt on his own property is not desirable. Indiana is still suffering from lack of public support for deer management policies, and this prevents a realistic harvest. Minnesota needs authority from their legislature to have longer open seasons to permit better manipulation of the harvest. Wisconsin suggests that ecologically based management units would be better than their present county boundaries. Further, their party permit system, whereby a party of four licensed deer hunters may kill one antlerless deer in a certain management unit (in addition to one antlered buck per hunter), does not give sufficient flexibility — too many permitholders in some areas, not enough in others. For example, they need individual permitholders in some areas, parties of two in others, and parties of four in others. Michigan is authorized to have antlerless deer hunting in the farmland only to alleviate crop damage or to alleviate highway hazards. This is fine, but these reasons are only legal "excuses" for an adequate deer harvest. The best reason is because deer hunting is an excellent source of recreation in an area where such is sorely needed, and large numbers of deer can and should be harvested legally. It's just plain good sport.

Farmland deer have to compete with a vast array of hazards — Oldsmobiles, fences, "delinquents" with 22's, dogs, bird hunters with itchy fingers, hungry humans disgusted with the rising price of beef and pork, and a growing army of licensed "redcoats." Studies in several States have shown that deer can easily be overharvested in the farm belt. For example, over 40 percent of the fall herd has been legally harvested at times in Illinois (Andrews and Calhoun 1968). Nevertheless, the herds are tremendously productive. Computations in Iowa indicate a gross increase of 70 percent over the spring breeding herd. This computation is substantiated by data from the University of Michigan's 2-square-mile fenced-in George Reserve northwest of Ann Arbor. Here all gains and losses to the herd are known.[1] This area of 40 percent open fields, 35 percent woodlots, 15 percent swamps and bogs, and 10 percent marshes, with a productivity of 18 fawns per 10 adult does and 7 fawns per 10 doe fawns, has produced a 70 percent annual increase — over the last 20 years — and this in turn has produced an annual kill of 21 deer per square mile. Forty-three percent of the total kill has been antlered bucks and 57 percent antlerless deer; or, putting it another way, 55 percent males and 45 percent females.

In the wild some of this production is wasted and conditions are not nearly as ideal, but much of the potential is there, and we ought to make use of it. To capitalize on this production requires good control of hunter numbers and hunting pressure. It requires logical, sensible, and not overly restrictive hunting regulations; it requires maintaining good landowner-hunter relationships; and it requires that we authorize a full and adequate kill of deer every year.

[1] *Jenkins, D. H. The productivity and management of deer on the Edwin S. George Reserve, Michigan. 1964. (Unpublished Ph.D. thesis on file at Univ. Mich.)*

LITERATURE CITED

Andrews, R. D., and Calhoun, J. C. 1968. Characteristics of a white-tailed deer population in Illinois. Ill. Dep. Conserv., Game Manage. Rep. 1, 8 p.

Bennett, C. L., Jr., Ryel, L. A., and Hawn, L. J. 1966. A history of Michigan deer hunting. Mich. Dep. Conserv., Research and Develop. Rep. 85, 66 p.

McNeil, R. J. 1962. Population dynamics and economic impact of deer in southern Michigan. Mich. Dep. Conserv., Game Div. Rep. 2395, 143 p.

Queal, L. M. 1968. Attitudes of landowners toward deer in southern Michigan, 1960 and 1965. Mich. Acad. Sci. 53: 51-72.

Ryel, L. A. 1968. The 1967 deer season. Mich. Dep. Conserv., Res. and Develop. Rep. 139, 11 p.

SOME REMARKS ON YARDING DEER

LOUIS J. VERME
Michigan Department of Natural Resources
Shingleton, Michigan

To me, the facts and figures reported for midwestern white-tails are rather astounding when contrasted to the dynamics of yarding deer in the northern Lake States. A few pertinent examples follow. Because of the bitter cold and deep snow, boreal deer normally huddle in the best shelter available to gain respite from the weather. Under such conditions, the animals promptly burn up their stored fat. They become fairly inactive in midwinter, thus conserving energy, and actually eat less browse compared to earlier in the winter. Possibly this phenomenon involves a downshifting of gears, physiologically speaking, which in some way helps the animals to stay alive. Nevertheless, many deer barely stagger out of the swamps at spring break-up, which commonly does not occur until mid-April.

Does that have been weakened by hunger produce stunted, unhealthy fawns. Following a harsh winter, we have evidence that as many as one-third to one-half of the fawns die at birth or soon after. As a result, hunters see far fewer tails flicking through the woods; hence, they are sure that all the deer are gone. Northern fawns on the average do not grow nearly as large as their southern cousins. Doe fawns rarely breed, let alone produce twins. Even the productivity of adult females is minimum — 10 to 15 percent of the yearling does are barren when the rut ends. The annual herd increment probably comes to less than 30 percent, and the actual (vs. potential) surplus is seldom if ever removed by hunting.

We consider it a good season when 1½-year-old males make up 50 percent of the legal bucks bagged. In Michigan's Upper Peninsula, the "rocking-chair" racks are grown by relatively old, tough bucks. Because of the hunter's quest for antlers, a large number of does survive to a ripe age of 10 to 15 years. The long-term prospects for northern deer are bleak indeed. With the possible exception of Wisconsin, a State blessed with many paper mills, the Lake States region is growing much more timber than is being harvested. Simply stated, more big trees mean that fewer deer can exist. A major miracle is needed to reverse the problem of serious range deterioration, but none is in sight.

DISCUSSION

Mr. Verme:

I would like to put Dr. Crawford on the spot. Hew, you have alluded to the fact that habitat conditions in the Midwest — and I assume you refer mainly to food and winter cover — probably will not favor deer in the future. Would you care to tell us in your judgment what might be done to retain or improve deer habitat on forested public lands.

Dr. Crawford:

Well, I think it's a matter of, first, more research — more research into what would increase the carrying capacity of these wooded lands. I assume you are talking about the marginal, submarginal type of timberlands, not about the real quality timberland, where I don't think we can do much; it probably doesn't amount to enough area to worry too much about. Basically, we need information on their food and cover needs. We need more basic information on stress caused by macro- and microclimatic factors. What do we know about cover manipulation in the nonyarding range? True, these deer do not yard, but the winter stress periods — including low temperature and winds — do affect animals. I don't think we know what we can do to manipulate the pattern to offset these climatic stresses on the animal. Basically, we don't really know what climatic stresses are, so I think we need to start out with some fairly basic research on the animal and then go from there to the habitat. We need to know how to manipulate the habitat to increase carrying capacity on the areas that we will have left for deer in the future.

Dr. Larry Jahn (Wisconsin):

I would like to direct a comment or question to Dr. Crawford. In his remarks he indicated we might be working toward a monotype environment in the agricultural region in which it is intensively utilized by people; but on the other hand we have another whole group of professional people engaged in planning. We're talking about green spans, flood plain zoning, and shoreland zoning which conceptually are vehicles for preserving habitat and diversity in the environment and the landscape itself. Do these concepts meet with your approval, or are you directly opposed to them? Do you see no hope for their application in the future? Depending upon your position, of course, you may put the planner in the position of just doing a futile job, really.

Dr. Crawford:

Well, no; I don't object to zoning proposals, but I don't see how they are going to offset a man from making a living. You say perhaps a certain area of the country will be zoned as nonagricultural. Well, this may be a little tough to sell to the man who is out there making his living from the agricultural aspects of the land. I tried to point out that the Midwestern United States is one of the most fertile areas in the world. In rough figures, 20 percent of the world's grain is produced on 5 percent of the land. Now, how this is going to affect zoning is a good question, but I think when we get into our zoning practices we'd better keep some of these factors in mind.

Dr. Jahn:

My point is that we can't resolve all these things by economics even though in your original remarks and your comments just offered you indicate that economics are the all-important vehicle for making decisions. Last night's speaker, Dr. E. S. Deevey, pointed out that there are certain things beyond the marketplace and the means of cost benefit calculations. I think that is exactly the position we are in at the present time. There are certain things that are good for society and there are good things to be done on a piece of landscape. This is why I'm pushing the point. I merely want to add another dimension to your original comments.

Dr. Crawford:

I don't necessarily say the comparison should be in dollars, but it should be in some comparative base. Granted what you say is true — there are esthetic values. Now, how do you put a dollar value on esthetics? Well, I don't think we've tried very hard in the past. I think we should try harder to develop some firm basis of comparison for arguing with a person who wants to grow corn or timber. When he says, "What does your product add to the economy," we've got to be able to tell him more than what comes from the heart. We've got to get it into more concrete terms. Perhaps you can't say a deer is worth so many dollars, but I think we'd better work for some means of concrete comparison so we *can* defend the resource that we are interested in. I don't think we have worked hard enough for this in the past. I think it is going to be much more important in the future.

Mr. Edwards (Illinois):

One of the things that has bothered me over the last few years is the fact that what we are dealing with here is a succession species. The fact is that the deer are doing best where some of the very early stages of secondary succession are best represented along with the later stages in the oak-hickory forest situation. And this simply means that if we are going to manage these species we are going to have to recognize disturbance—disturbed environments—in our management programs. And if we are going to do this we've got to recognize management measures, such as controlled burning, and some certain types of timber harvest in our management programs. We've got to come to grips with disturbance in our management, and this is about it. Until we are ready

to recognize what succession and disturbance really mean in the ecology of our species, we aren't going to make any progress in management. We've got to come back to succession management; we've got to come back to listen to what other people like Wallace Grange really had to tell us 20 years ago.

Mr. Murphy:

I think this is what I was really referring to when I said that if we are going to give the deer the help they need to meet the growing demand for them, we are going to have to get more specific in our management recommendations. All of these management recommendations, however, come back to the need for research. In other words, you say burn — what time of the year do you burn, under what conditions do you burn, in what habitat do you burn, what results do you get from this burn? Burning is merely one tool, but we need the research. We're fighting this now in Missouri. We're buying land, and the men on the management staff are coming and saying, "What practice can we apply on this land? If we do such and such — what happens?" Well, we're getting the cart before the horse. Instead of putting $80,000 into management, we should put it into research to get the answer before we act.

Dr. Gross (Colorado):

I'm unfamiliar with your deer management practices and research activities in this area, but I would like to direct a question to anyone on the panel. Has anyone been able to place a quantitative relationship between deer densities and browse availability below that point where deer starvation sets in? We've spent many millions of dollars on browse surveys, carrying capacities, and so forth. Have we in any single instance yet gotten to the point that we can equate deer densities with browse availability below that point where a catastrophe occurs? Has anyone been able to say that a given range will carry 235 deer per square mile, or 14 deer per square mile, below that point where some very serious occurrence happens to the herd?

Mr. Murphy:

We went this direction in the forage survey which I mentioned briefly. This was an extensive survey of understory vegetation on National Forest lands in Missouri. There are about 2 million acres. We spent an entire summer with a field crew measuring the understory vegetation. We've determined the pounds per acre of available deer forage for the summer and for the winter. From this we have calculated the carrying capacity for this land. In the black-scarlet oak forest type which covers the majority of the land area, it's only three to five deer per square mile in the winter time. And this in many areas is at carrying capacity at the present time. In most forest types, it was less than eight deer per square mile. The deer are not in excess on any of this land at the present time, and range deterioration is not occurring because we harvest them annually on an any-deer basis. Does this answer your question? Is that what you were looking for?

Dr. Gross:

More or less. The point is, has this really been proved? Would this range carry eight deer per square mile?

Mr. Murphy:

All right. Let's take another example of Hew Crawford's work in Arkansas. They established two 1-square-mile enclosures. They shot out the deer entirely, then restocked at known levels and have censused these deer annually. Browse production surveys indicated that those areas could carry eight deer per square mile. All right, they had a couple of years of good acorn crops, and the herd increased to above eight (perhaps 12 to 15) deer per square mile. Then came a year of acorn failure and they died back to eight per square mile.

Dr. Crawford:

It wasn't just a browse survey — this is the important point. This was all vegetation available for deer during winter. Now, the Ozarks probably have had more food habits work done than, I suppose, any other region of the country. So we knew pretty well what they were eating. It wasn't just browse, but the plants that were known to be deer food — not the oak sprouts, not the hickory sprouts — but the food plants. I think this is one of the keys. I know there have been a lot of browse surveys made, and everybody has assumed that deer eat browse. We're doing some food habits work in the Southeast now, and we haven't found many woody twigs utilized during winter — spring, yes — but during winter there may be one or two instances of hardened woody twigs being browsed.

Dr. Jenkins:

It's almost predictable that when researchers and deer managers get together the deer managers will say we need some research to indicate to us what will happen if we treat a piece of land in a certain way. Have either the researchers or the managers ever sat down and tried to work out the various combinations — the astronomical number of combinations of factors that are working on a piece of land that determine what happens if you do this or that? They say, now, if you take a swamp edge and cut it over *this* way, this will happen. In a pig's ear it will! It might happen sometime, but it isn't going to happen that way all the time. We'll be lucky if it responds that way 10 percent of the time. I wonder if the time will ever come when we can develop a good way to measure habitat. Sure, we can do it at the research level, but how do you do it statewide? How do you turn it over

to all the district men and have them all working on the range measurements? They'd never do anything else. When would they do the prairie chicken dancing surveys and other things they have to do that are absolutely important? So we come up with another way to look at this. Perhaps we can put a "computer" out in the woods and feed all the information into that computer and then have it feed back the answers as to what the range conditions are. You know what the computer is — a deer. He takes all the data — all the known climatic data and all the range factors and snow depth and everything else — and he puts them through his computer and he comes up with a certain physiological condition. Now we have to learn to measure those factors. Once we can learn to measure the deer and get the information out of him, we might be able to come to this point where we say we are carrying just enough deer or we are carrying too few deer. It is very difficult to measure range conditions — and do it on a practical basis so you can do it in the spring of the year before you set your hunting regulations. That's the practical end of the thing.

Mr. Verme:

I would like to make a comment in addition to what Dave has said. Part of our problem, at least in the far north, is that we don't really understand what motivates this animal — what he's responding to. Deer, even in our winter yards, are not uniformly distributed throughout the area. There are pockets, little niches that supply exactly what they are seeking. We can go through a swamp and possibly make a browse analysis survey to determine the carrying capacity, and we find that on the average, a swamp may be in pretty good food condition and yet where the deer are, they are starving. Perhaps this doesn't apply quite as rigidly in the Midwest, but I think it's important to try to understand this animal before we run out and make browse surveys or try to do some habitat improvement programs. It won't always work because the deer just don't follow in the same directions.

Dr. McCollough (University of Michigan):

I agree with Dave about the difficulties here and it's sort of the Harvard Law of animal behavior — under carefully controlled conditions, deer behave as they damn well please. On the other hand, if we take this approach I'm sure we're closing some potential doors. In other words, if we assume that the variables are so great that we can't possibly measure them, we aren't going to try. At Michigan we *are* trying certain things. Now, not all species are equally good deer food, and there are things known as ice cream species which have potentials of indicating the capacity of the land in relation to the current density of deer. And there is a possibility of modeling systems using this sort of species. Now, I would just like to point out first of all that tomorrow there will be a talk by Dennis King who is working on Garden Island and is attempting to do this sort of thing: unfortunately, it hasn't worked out as well as it could, but there are some qualifying factors, too.

Now on the George Reserve, our present studies are going this way: we can follow the deer population very precisely, and we're looking around in the environment — in the habitat — for certain species which will reflect what's going on so that we can find this series of species that will work at any given level: some that are very immune to browsing, some that are very sensitive. A combination of measurements on these species might reflect exactly what is going on.

Now I want to add a little bit to the variability of this system myself by commenting on the fawn weights given by Dean Murphy earlier. Fawn weights are really not only related to fertility of soils: the factor of density has to be taken into account. On the George Reserve I'm sure we could produce fawns to about 70 or 80 pounds, and we can produce them up to 100 pounds, depending on the density of deer we keep on the area. This brings another point into focus and that is we talk about carrying capacity as if it were one thing. As a matter of fact, there's a whole range of potential carrying capacities, depending on what you want to accomplish and what sort of changes in vegetation you are willing to accept. If you don't want *any* species on the area damaged, you're talking about a carrying capacity that is zero. Some plant species go out as soon as a deer comes in. But you have to make some sort of judgment as to what you are willing to sacrifice. In terms of the George Reserve, you can say there is one carrying capacity that gives the optimum harvest. There is another carrying capacity that can be maintained over a sustained period of time if you are willing to give up some of the fawn crops. But you can maintain a standing crop, i.e., the existing biomass, out there very well. So the carrying capacity of the George Reserve might be anyplace between 60 and 120 animals, but you have to make up your mind what you mean by carrying capacity.

Mr. Nixon:

There has been a good bit of talk in the last 15 to 20 minutes about carrying capacity as it relates to the woody hardwood cover or range of the deer. We tend to think of them as farm animals. In Ohio when we talk about carrying capacities there are two other areas that desperately need research — crop damage and highway kills. We've got areas in northeast Ohio today that could support far more deer than they do, yet we can't stockpile them. We lose them, just as fast as they are produced, on the highways. We know very little about what motivates deer to cross roads,

how to keep them off roads, how to keep them out of orchards and other crop areas once these patterns are established. Yet, when you talk about carrying capacity, in much of the agricultural range you are talking about agricultural crops. This is the carrying capacity as far as food habits. The wooded range functions primarily as daytime cover, not food. And in order to approach a reasonable carrying capacity in terms of harvest, we need to do something to mitigate these other losses.

Dr. Cowan (Michigan):

I have a couple of comments. Hew, I've seen white-tails in South Dakota where you have to travel an awful long way to find any woody cover at all. I'm wondering whether your pessimistic view of the ultimate demise of our woody cover through the Midwest necessarily means disappearance totally of the white-tail from the area. Also, I would like to find out from Dave what ideas he may have for getting to the regulations he says we should have in order to manage these farmland deer.

Dr. Crawford:

I'm not familiar with the situation in South Dakota, but I would guess two factors affect their ability to support deer herds. First, perhaps some of the hilly areas are important; this has some influence when you compare it with our flat table lands in the central Midwest. Secondly, aren't those white-tails in South Dakota pretty much related to the draws that are somewhat brushy, and isn't woody cover a part of their environment? If woody cover isn't important I'll be surprised, because work done in Iowa and Kansas has shown that it is quite important. The areas where they have deer are areas where they have woody cover. Another thing, I don't think it will just be cover. I think in the future it could very well be food. As I mentioned, right now there is a lot of crop wastage and plenty for the deer to eat through the winter — corn spillage and soy beans. But I think future technology will increase the efficiency of harvesting. I don't think you'll get as much crop loss in the future as we have now — it's substantial now. More efficient harvesting will be another way for the landowner to make money and, judging from what agricultural research has done in the past, I'm sure harvesting will be improved in the future. So food may be a problem also. Time will tell.

Dr. Cowan:

I think that you will probably find that the farmer will be a greater determinant in such an intensive situation than the actual availability of cover or food will be.

Dr. Crawford:

I think the farmer will be very important in the future. Whether he wants deer or not will determine whether we have deer or not, and if he can realize some return from having deer I think that's going to increase the likelihood that we will have deer in the future.

Mr. Verme:

Arch, I think you are meaning to say, or ask the question, do deer really need cover in the Dakotas for winter survival? Now, that brings up a point. Moen, in a recent issue of *Ecology* and in *The Journal of Wildlife Management,* brought up the same question; and he claims that despite a tremendous amount of heat loss, say in western Minnesota, the deer didn't seem to mind the bitter cold and got along and fed actively at night when the heat loss was quite severe. But this is only where they have excellent farm crop foods available. They have to take in more energy than they are losing. In areas where this nutritious food is not available, I would think — without knowing too much about the western conditions — that cover is highly essential for white-tails. The farther south you go, of course, the less important it is.

Dr. Cowan:

This is what you've been talking about — the most fertile farmland in the country.

Mr. Verme:

Well, it may or may not be fertile or the food may not be available during mid-winter under this 2 to 3 feet of snow. Then what will the animal do? He has to conserve energy in some manner to stay alive, and cover is important.

Dr. Jenkins:

What can we do — what practical hunting regulations should we have? Well, first of all, every square mile, every square millimeter, of southern Michigan, of southern anything else should be open to deer hunting to provide the greatest hunting opportunity where the landowner will permit it, of course. No deer should be illegal, and the kill should be controlled by controlling the number of hunters. Where you have large numbers of hunters, they should be properly distributed by some type of a system. Now, where you only have few hunters it doesn't make much difference. We ought to head for a harvest of about half antlered and half antlerless deer. We ought to head for sensible firearms regulations. My home State of Pennsylvania, up until recent years, did not permit buckshot to be used. It was an abomination; it was horrible; it was sinful, you see. Right across the river, in New Jersey, you couldn't even use a rifled slug. It was sinful; it was horrible! I think we ought to head for a type of hunting regulation that is effective and sensible. I think this muzzle-loader business is coming right along. Our reason for sticking to shotguns is not real good. It's a real uphill battle to convince the County Board of Supervisors that they should permit the use of rifles. But I think this

would improve the sport, and interest in it, if rifles were allowed. We'll have to say we're not going to have deer populations above a certain level because of certain practical reasons, such as crop damage and automobile damage. But the main thing is to have as liberal hunting regulations as possible, with all areas open but with the distribution and size of the kill controlled. Some type of a permit system may be necessary, as we mentioned. And we ought to aim for a 50:50 antlered-antlerless ratio, not a 90:10 ratio.

Dr. Jahn:

I don't know what sections of South Dakota Arch was referring to, but there are some sections in that type in winter in which wetland habitat functions as a woodlot and serves as excellent cover for white-tailed deer; beds are abundant and the animals are found there. Similarly, in southern Wisconsin large marsh areas of wetland habitat — emergent wetland vegetation — serve as excellent cover. Deer do survive, and it becomes in effect an anchor within their home range for bedding purposes, by and large, or escape cover. Also, the stress seems to be on the parts of woody cover within this agricultural block of this country. Does anyone on the panel know if any of these States have some sort of a program for woodlot preservation? If so, what are the mechanisms for maintaining privately owned woodlots?

Dr. Crawford:

Probably someone else could answer this better than I, but there are standard ACP payments for practices conducted on woodlands and other economic inducements. I don't know if this is strictly for woodlot preservation. It's managed by and large under ACP. I'm speaking of preservation or maintenance of, say, 20- or 40-acre blocks of woodland. There is a fairly strong force called farm foresters who are very enthusiastic about the resource they work on, and I imagine they are rather influential. But as far as a formal program goes, I don't know.

Mr. Nixon:

Ohio has a law on the books whereby they get a tax credit write-off for woodlot preservation, but unfortunately the tax assessor will take it off a woodlot and put it on somewhere else. So really there's no attempt made to save the woods, and in western Ohio we are losing it fast.

Dr. Jahn:

That same thing with the tax write-off and differential assessment is an old law in Wisconsin. You are absolutely right — the assessor makes the adjustment and puts the increased rider on the remaining taxed property.

Mr. Hallam (Virginia):

I noticed that most States harvest their bucks at such a high rate that few reach a very old age. I wonder if Dr. Jenkins or someone else on the panel feels that there is a place for trophy management on public lands.

Dr. Jenkins:

You develop trophies in two ways — either they have to live long enough to grow big enough or you feed them like crazy so they will grow a trophy rack in, say, 2½ years. When you start talking about 600 to 800 thousand deer hunters in the State — we have that in this country — I think that you are very shortly going to see the time when you cannot grow trophies under those conditions unless you have some area inaccessible to hunters; and with snowmobiles, a hunter can get anyplace. So, I think that the idea of trophy hunting — or quality hunting if you will — is something that we cannot look forward to in heavily hunted States. I think the trophy hunter is going to have to look someplace else. Now we can set aside certain areas for light hunting, but there are two things that affect deer numbers that we mentioned here before. A deer is a creature of the early stages of succession, and as the land changes, the numbers and kinds of animals that live there change; that's the great truth. And so as the land grows up you'll be able to carry fewer and fewer deer. Deer must be held within limits of their food supply or the herd is in trouble. The idea of restricting hunting in those places in order to create trophy hunting is something else. Now it may well be in the farmland country that a 2½-year-old deer is a trophy deer — he's a darned good looking deer. One of the largest deer — in terms of antler size — ever shot was only 3½ years old, and it's not too hard to have a deer live to be 3½ years old in some of the areas where there is a lot of private land. But the chances are getting less and less. There are more and more people and there is more and more accessibility. Of course, what was a trophy to my grandfather and what is a trophy to me are two different things, you see, so we have that change, too; but I'm not optimistic about trophy hunting, nor am I optimistic about whether you could set an area aside and restrict the kill of deer (or restrict hunter accessibility — which is restricting kill of deer) to create trophy hunting. Maybe somebody might have a different idea, but if he has I'm always glad to hear how he's going to work it out — deer being an herbivore and therefore his own worst enemy.

Dr. McCullough:

I don't have a question but I do have a comment on this past question. I don't think there's a population in the country that has been shot as heavily as the George Reserve population over anything like that in many years, and we have at least six bucks out of a hundred out there right now that anybody in this room would be proud to have on his wall. I don't think you really give up trophy bucks by heavy

shooting. You may reduce the number of them, but certainly they are out there, and it takes a darned good hunter to get them.

Dr. Jenkins:

I won't argue, Dale. It just depends on what you call a trophy. What I was calling trophy is one that would qualify for the Boone and Crockett Club. I agree that there are some nice deer running around in southern Michigan and on the George Reserve that make good trophies, but it all depends on what you call a trophy. If you want a Boone and Crockett Club record, they aren't on the George Reserve, Dale. Having been an official scorer for a couple of years, I believe that unless a rack is as big as a bushel basket there is no point in wasting time measuring.

SUMMARY

LOUIS J. VERME

Michigan Department of Natural Resources
Shingleton, Michigan

A brief resume is in order to wrap up this stimulating symposium. Generally, the picture for midwestern white-tails is fairly bright, at least during the next few years. A herd numbering 1 million animals by the early 1970's is a mighty impressive total. Beyond the next decade, however, the situation evidently may take a sharp downturn locally, if not more extensively. Due to expanding human population, suburbia will continue to encroach on what presently is good deer range. Changing economics probably will dictate that relatively fertile farmland be utilized intensively for agricultural crops, almost to the point of excluding deer in the Corn Belt. Woodlots may be overcut or improperly cut, thus eliminating essential cover for deer. In some instances the woodlands will be converted to grassland to grow livestock. On the other hand, some currently submarginal acreage is actually reverting to lush deer habitat, as is now the case in southern Michigan, for example.

High human densities and deer are surprisingly compatible. But when the situation becomes seriously imbalanced, deer obviously must give ground. Chances are that incidental mortality of deer from such things as automobile collisions, poaching, and free-running dogs will continue to worsen. To prevent such waste of venison, the legal harvest must be maintained as high as possible, closely exploiting the great reproductive potential of well-fed does. We seem to be headed in the right direction in this regard, even if not fast enough or in unison.

Apparently, henceforth we will have to manage more intensively on steadily diminishing deer range, working with land of poorer carrying capacity as well. Do we have the necessary knowledge, incentive, or support to accomplish the job? We probably can do little to alter the strong socioeconomic pressures and and changing living patterns. However, it seems doubtful that we know enough about the basic biology, ecology, and behavioral aspects of deer to make the most of this resource. So far we have been managing deer by the "seat-of-our-pants," and fortunately getting away with it. I fully concur with Dean Murphy that we must develop game management from the art that it has been to a precise science.

This symposium logically serves as a focal point for documenting available information about midwestern white-tails. But it also emphasizes our shortcomings in terms of what we ought to know and where we are headed. Clearly, we are being challenged to better manage our fine deer herds in the midwestern farmbelt. From all indications, the prospects for success are encouraging.

SOME RECENT RESEARCH PAPERS OF THE NORTH CENTRAL FOREST EXPERIMENT STATION

Prescribed Burning Weather in Minnesota, by Rodney W. Sando. USDA Forest Serv. Res. Pap. NC-28, 8 p., illus. 1969.

Durable Rustic Wooden Signboards, by Glenn A. Cooper. USDA Forest Serv. Res. Pap. NC-29, 15 p., illus. 1969.

The Market for Wood Picnic Structures, by Jerry A. Sesco. USDA Forest Serv. Res. Pap. NC-30, 7 p., illus. 1969.

Oak Forests of the Lake States and Their Management, by John L. Arend and Harold F. Scholz. USDA Forest Serv. Res. Pap. NC-31, 36 p., illus. 1969.

Wildlife Esthetics & Auto Campers in the Superior National Forest, by David W. Lime and Charles T. Cushwa. USDA Forest Serv. Res. Pap. NC-32, 8 p., illus. 1969.

Standing Timber Coefficients for Indiana Walnut Log Production, by James E. Blyth, Edwin Kallio, and John C. Callahan. USDA Forest Serv. Res. Pap. NC-33, 9 p., illus. 1969.

Climatic Conditions Preceding Historically Great Fires in the North Central Region, by Donald A. Haines and Rodney W. Sando. USDA Forest Serv. Res. Pap. NC-34, 19 p., illus. 1969.

Initial Thinning in Red Pine Plantations, by John H. Cooley. USDA Forest Serv. Res. Pap. NC-35, 6 p., illus. 1969.

Biological Growth Functions Describe Published Site Index Curves for Lake States Timber Species, by Allen L. Lundgren and William A. Dolid. USDA Forest Serv. Res. Pap. NC-36, 9 p., illus. 1970.

Defect Indicators in Sugar Maple — A Photographic Guide, by Richard M. Marden and Charles L. Stayton. USDA Forest Serv. Res. Pap. NC-37, 29 p., illus. 1970.

ABOUT THE FOREST SERVICE . . .

As our Nation grows, people expect and need more from their forests — more wood; more water, fish, and wildlife; more recreation and natural beauty; more special forest products and forage. The Forest Service of the U.S. Department of Agriculture helps to fulfill these expectations and needs through three major activities:

- Conducting forest and range research at over 75 locations ranging from Puerto Rico to Alaska to Hawaii.
- Participating with all State forestry agencies in cooperative programs to protect, improve, and wisely use our Country's 395 million acres of State, local, and private forest lands.
- Managing and protecting the 187-million acre National Forest System.

The Forest Service does this by encouraging use of the new knowledge that research scientists develop; by setting an example in managing, under sustained yield, the National Forests and Grasslands for multiple use purposes; and by cooperating with all States and with private citizens in their efforts to achieve better management, protection, and use of forest resources.

Traditionally, Forest Service people have been active members of the communities and towns in which they live and work. They strive to secure for all, continuous benefits from the Country's forest resources.

For more than 60 years, the Forest Service has been serving the Nation as a leading natural resource conservation agency.